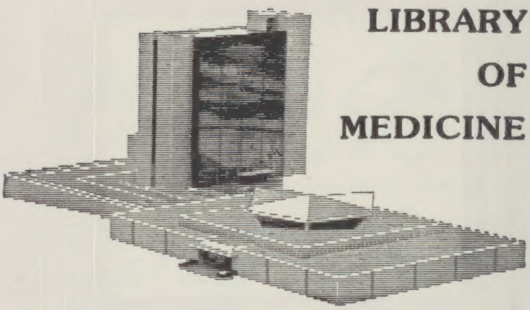

THE

SCIENCE AND ART

OF

SURGERY.

BEING

A TREATISE ON SURGICAL INJURIES, DISEASES, AND OPERATIONS.

BY

JOHN ERIC ERICHSEN, F.R.S., F.R.C.S.,

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REVISED BY THE AUTHOR,

FROM THE SEVENTH AND ENLARGED ENGLISH EDITION.

Illustrated with Eight Hundred and Sixty-two Engravings on Wood.

VOL. I.

PHILADELPHIA:
HENRY C. LEA'S SON & CO.
1881.

"*They be the best* Chirurgeons *which being learned incline to the traditions of experience, or being empirics incline to the methods of learning.*"

BACON *on Learning.*

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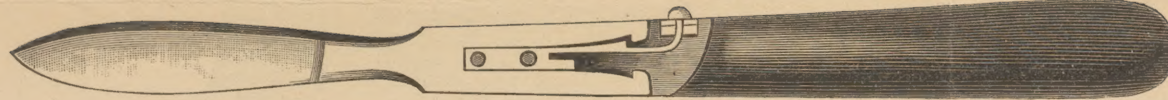


The above cuts show the object of the invention, viz.: To provide an improved means of detachably fitting to a handle different blades or similar instruments, whereby one handle may answer for a number of different instruments.

The plan for using a single handle for different blades, due provision being made for securing them together and readily detaching them, has long been practiced in many different ways, but my invention I conceive to be a substantially better and more convenient means for accomplishing the same object.

Physicians and Surgeons, when using such improvements as these, require a readily detachable blade which is firmly held in its place in its handle. The shape of the handle is of prime importance, and the presence of any device in the handle for securing and releasing the blade is a serious objection if it is in any way likely to form an obstruction to the free use of the handle, or of such character that it is likely to be accidentally turned or otherwise operated when it is not desired.

The requirements of a device which entirely avoids objections of the heretofore existing handles I have secured to my improvement, in which a bifurgated handle containing a spring catch operated by a push button projecting slightly out from the handle, a blade with a bifurgated shank, which when pushed into the slot in the end of the handle receives the catch therein between its ends and is locked in place thereby. This is a general plan of construction, the details are shown in the accompanying drawings.

Our handles have the simplest and most durable lock-mechanism of any detachable knife in existence; our knives are made of the best Sheffield steel and are all **hand-forged.**

Old pocket cases overhauled and all kinds of Instruments repaired.

Very Respectfully Yours,

PREFACE

TO THE NEW AMERICAN EDITION.

I HAVE endeavored to make this Edition of "The Science and Art of Surgery" more deserving than those which preceded it have been of the favor that has been accorded to them by the Surgical Profession of the United States of America.

In consequence of unavoidable delays in the publication of the Seventh British Edition, I have found time to add to this one several paragraphs on important practical subjects, which will, I trust, be found to enhance the utility of the work as a guide to the Practitioner of Surgery.

I dedicate these volumes to the Surgical Profession of the United States of America, in testimony of the esteem which I entertain for that large and enlightened body of practitioners, and of the cordial friendship that exists between me and many of its members.

JOHN ERIC ERICHSEN.

LONDON, *October*, 1877.

PREFACE

TO THE SEVENTH ENGLISH EDITION.

THE favor with which successive Editions of this work have been received not only by the Profession in this country and its colonies, but by means of Reprints in the United States of America, and through the medium of translations on the Continent of Europe, gratifying as it necessarily is to the author, has in no small degree increased his responsibilities.

The Author feels that a responsibility, weighty in proportion to the very extent of the diffusion of his Instruction, is incurred by him who takes upon himself the task of teaching others that Science which underlies the Art, and that Art, the exercise of which constitutes the application to Practice of a great branch of Medical Knowledge, which more directly than any other department of Medicine involves the physical well-being, and more immediately affects the life of those on whom it is exercised.

It is not sufficient for the Teaching of a Scientific Art, such as Surgery, to be sound in those General Laws that constitute its Principles. It must also be accurate in those minute details that are necessary to its successful Practice, and, above all, just in its estimate of the labors of others.

A Teacher of Surgery, who seeks to give a true and impartial view of the subject of his tuition, is placed in much the same position as a Judge who is summing up a great cause.

He must endeavor to divest himself of the trammels of the Schools—to free himself alike from the partisanship of individual bias and the antagonism of professional prejudice.

He must lay down clearly the broad General Principles on which the Case rests; detail its facts in an orderly and succinct manner, draw those deductions which legitimately flow therefrom, and guide his Pupils to arrive at just conclusions by the light of his own more matured and extended experience.

Feeling deeply the responsibilities that thus attach themselves to him as a Teacher, the Author has spared no exertion in endeavoring to render the Seventh Edition of "The Science and Art of Surgery" worthy of the continued confidence of the Profession.

With this view the whole Work has been carefully revised, and while no change has been made in the general arrangement of the various subjects of which it treats, much new and important matter has been added. The additions thus made have not been confined to any one particular part, but have been widely distributed through the various subjects of which the Work treats. They are not to be measured merely by the increased bulk of the Work, being, in reality, far more extensive than may at first appear, as they often take the place of old matter that, having become obsolete, has been cancelled.

One Hundred and Fifty new Illustrations have been added to the Text, and many of the old ones have been redrawn in an improved style. Whenever a Woodcut has been copied from another Work, the name of the Author of the Work whence it has been taken has been appended to it. When no such acknowledgment is made, the Figure is original, belongs exclusively to this Work, and, except in the case of Diagrams, has been drawn from Nature.

To his friend and former Pupil, Mr. R. I. Goodlee, the Author is indebted for a series of Microscopical Illustrations of Pathological Subjects, which have been drawn expressly for this Work. They are alike true to nature and admirable in execution, and will, it is hoped, be found of much use to the Student of Surgical Pathology.

Throughout the Work it has been the object of its Author to place before the Student and Practitioner the Science and the Art of Surgery, not as consisting merely in the observation of such Injuries, Diseases, and Malformations, as are met with in Surgical

Practice, or in the dexterous application of manual or operative means for their relief; but as demanding an exercise of general medical knowledge, and a thorough acquaintance with all those conditions, whether intrinsic to the patient, or surrounding him, that favor or prevent his restoration to health. The remarks in the earlier part of the First Chapter, will, it is trusted, sufficiently indicate to the Student what is required of him in order that he may become a successful Practitioner of Surgery.

In every instance an endeavor has been made to give as full and clear a description of Symptoms, Pathology, Diagnosis, and Treatment, as the importance of each demands, and the present state of Surgical knowledge permits.

The various new Operations practised in modern Surgery have been carefully described, the difficulties and dangers attending their performance pointed out, and the cases requiring them detailed.

The growing importance of Surgical Hygiene has led to special attention being paid to it in the Chapters on Operations, Wounds, and Septic Disease.

With respect to Diagnosis it may be remarked that, as accuracy in this branch is an all-important requisite for success in Treatment, the signs and symptoms by which the injury or disease under consideration may be recognized, have not only been described in each case, but care has been taken, even at the risk of occasional repetition, to point out the several conditions with which it may be confounded, and the means of distinguishing it from each of them.

In order to facilitate reference to the very varied subjects of which the Work treats, each Volume has been furnished with a Table of Contents, a List of Illustrations, and an extended Etymological Index.

It only remains for the author to record his acknowledgments to his friends, Messrs. Beck and Tweedy, who have given him their valuable assistance in his endeavor to bring this Edition to the level of modern scientific Surgery. To Mr. Beck the Author is especially indebted for much valuable assistance throughout the

Work, but more especially in those Chapters that relate to general Surgical Pathology.

In conclusion the Author can but hope that this Edition of the "Science and Art of Surgery" may not be found undeserving of the continued confidence of the Surgical Profession, as a guide to the Practitioner, and a Text-Book for the Student in Surgery.

JOHN ERIC ERICHSEN.

6, Cavendish Place, London,
October, 1877.

CONTENTS OF THE FIRST VOLUME.

DIVISION FIRST.

FIRST PRINCIPLES.

CHAPTER I.—GENERAL CONSIDERATIONS ON OPERATIONS.

CHAPTER II.—AMPUTATIONS AND DISARTICULATIONS.

CHAPTER III.—SPECIAL AMPUTATIONS.

Chapter VII.—The Progress of Repair.

DIVISION SECOND.

SURGICAL INJURIES.

INJURIES AFFECTING THE TISSUES GENERALLY.

Chapter VIII.—Constitutional Effects of Injury.

Chapter IX.—Injuries of Soft Parts.

Chapter X.—Gunshot-Wounds.

Chapter XI.—Poisoned Wounds.

Chapter XII.—Effects of Heat and Cold.

Chapter XIII.—Injuries of Blood-Vessels.

Chapter XIV.—Arrest of Arterial Hæmorrhage.

Chapter XV.—Traumatic Aneurism and Arterio-Venous Wounds.

Chapter XVI.—Wounds of Special Blood-Vessels.

CHAPTER XXII.—DISLOCATIONS.

CHAPTER XXIII.—SPECIAL DISLOCATIONS.

Chapter XXVI.—Injuries of the Face and Adjacent Parts.

Chapter XXVII.—Injuries of throat: and Asphyxia.

Chapter XXVIII.—Injuries of the Chest.

Chapter XXIX.—Injuries of the Abdomen and Pelvis.

DIVISION THIRD.

SURGICAL DISEASES.

CHAPTER XXX.—MORTIFICATION, OR GANGRENE.

CHAPTER XXXI.—DISEASES ARISING FROM THE ABSORPTION OF SEPTIC MATTER, OR THE PRODUCTS OF INFECTIVE INFLAMMATION.

CHAPTER XXXII.—ERYSIPELAS.

CHAPTER XXXIII.—PYÆMIA.

CHAPTER XXXIV.—TUMORS.

Chapter XXXV.—Scrofula and Tubercle.

Chapter XXXVI.—Venereal Diseases.

Chapter XXXVII.—Surgical Diseases of the Skin and its Appendages.

CHAPTER XXXVIII.—DISEASES OF THE NERVOUS SYSTEM.

CHAPTER XXXIX.—DISEASES OF THE LYMPHATICS AND THEIR GLANDS.

CHAPTER XL.—DISEASES OF VEINS.

CHAPTER XLI.—ANEURISM BY ANASTOMOSIS; AND NÆVUS.

LIST OF ILLUSTRATIONS IN VOL. I.

SCIENCE AND ART OF SURGERY.

DIVISION FIRST.

FIRST PRINCIPLES.

CHAPTER I.

GENERAL CONSIDERATIONS ON OPERATIONS.

By a Surgical Operation is meant a Manual or Mechanical Process undertaken by the Surgeon for the remedy of Deformity, congenital or acquired, or for the cure or relief of a patient suffering from those effects of Injury or Disease, that are incurable by constitutional or ordinary local treatment, or in which such treatment would be too slow in effecting the desired result.

A *Surgical Operation* may be necessary for the following objects:

1. *Remedying or Removing Congenital Defects and Malformations:* as Harelip, Club-foot, or Supernumerary Fingers or Toes.

2. *Remedying Acquired Defects and Deformities:* as in the Closure of Fistulæ, the Restoration of Lost Parts, and the Correction of Distortions of the Limbs.

3. The *Removal of Foreign Substances* from the Body: as in the Extraction of a Bullet or a Calculus.

4. The *Repair of the Effects of Injuries:* as in the treatment of certain Fractures and Dislocations.

5. The *Removal of Parts* that have been so disorganized by the effects of *Injury* that their vitality is lost, or that their continued connection with the rest of the body would be a source of danger: as in Amputation for Frost-bite or Mangled Limbs.

6. The *Removal of Diseased Structures* that interfere with the utility of an organ or part: as in the Extraction of a Cataract.

7. The *Removal of Diseased Structures* that seriously inconvenience the patient or that remotely threaten life: as in the Extirpation of Tumors, Simple or Malignant.

8. *Rescuing a Patient from Immediate and Inevitable Death:* as in Tying a Bleeding Artery, Opening the Windpipe in Laryngeal Obstructions, Relieving an Over-distended Bladder, or Dividing the Stricture in Strangulated Hernia.

Operative Surgery is but the application of manipulative methods to the relief and cure of injury and disease. Like every other art, be it manipulative, plastic, or imitative, it can only be carried to a certain

definite point of excellence. An art may be modified—it may be varied—but it cannot be perfected beyond certain attainable limits. And so it is, and indeed must be, with that of Surgery. There cannot always be fresh fields for conquest by the knife. There must be portions of the human frame that will ever remain sacred from its intrusion—at least, in the Surgeon's hand.

That we have nearly, if not quite, reached these final limits there can be little question. When we reflect that every large artery in the human body up to the aorta itself has been repeatedly ligatured—that each of the six large articulations and many of the smaller bones have been resected—that the amputation of each limb up to the shoulder and hip-joints is a matter of ordinary surgical occurrence—that large tumors having the most intricate anatomical connections have been removed from every surgical region in the body, from the base of the brain to the lowest organ in the pelvic cavity—when we reflect on triumphs of the Surgeon's art that are expressed by operations such as these, we can scarcely believe otherwise than that little remains for the daring of the boldest to devise, or the skill of the most dexterous to accomplish, in the extension of that art in the direction of its operative department, and that the Surgeon must in future be content to repeat, though possibly in a modified and improved manner, those operations that have been inaugurated by the genius and perfected by the skill of his predecessors.

It is true that there are yet regions that have rarely been successfully invaded by the scalpel, though they have been contemplated as possible seats of future surgical operations. But it has yet to be determined whether some operations recently performed for the removal of important organs are more than bold experiments on the power of endurance of the human frame; whether they are surgical triumphs or operative audacities.

To my mind, it appears as if we had already reached something like finality in the mere manipulative art of Surgery; though I hesitate much to use that word "finality," for I know well how apt a man is to suppose that art to the prosecution of which he has devoted his life to have attained its final limit of perfectness. Yet, looking at the question as dispassionately as possible, we cannot but come to the conclusion that we can scarcely hope to pass far beyond the line at which we have arrived, in the direction of extreme precision and almost absolute certainty in the mechanical performance of the operations of surgery, and that in this direction the progress of modern Surgery is nearly barred. At the same time, we may reasonably expect that the details of the methods of practising operations may from time to time be materially modified and improved by the skill of individual operators, by the ingenuity of surgical mechanicians, or possibly by the introduction of new agents, such as electricity, as aids to our art.

But if modern operative Surgery has attained to so high a pitch of perfection in all that relates to boldness of conception and to precision of execution, so that we can scarcely hope to see any further progress in these directions; and, indeed, if the most advanced modern Surgery is seeking to lay aside the scalpel and the bistoury for milder methods of treatment—if, in fact, the practical department of Surgery has, so far as our present means and our present knowledge are concerned, reached, or nearly so, its final development, the case is widely different the with other great branch of Surgery—the *scientific.*

For here, truly, so far from having approached the final limits of our subject, we are but as yet halting on the threshold. And whether we

regard the science of Surgery in its relation to the essential nature, the character, the recognition, and the pathology of surgical diseases, and injuries, or whether we consider it in reference to all those circumstances which, independently of the mechanical skill of the operator, influence for good or for ill the results of his procedures, we have a field before us as vast as it has hitherto been little cultivated.

And here I do not speak of the mere local results; so far as they are concerned, there is but little to be desired. The results of most plastic, conservative, and ophthalmic operations are as satisfactory as the most sanguine could hope for or the most critical expect. So also with respect to that multitude of minor operations that are practised for the relief of various distressing maladies, and which are followed by the happiest consequences. But when we come to consider the issues of those greater and graver operations by which the life of a patient is directly imperilled, we are constrained to admit that success in results has lagged far behind and borne no relation to the perfection in the execution of the operation, and that in this respect the highly polished Art of modern Surgery far outshines its Science. But success in the results is, after all, the thing to aim at, and no amount of manual dexterity can compensate for its want. Dexterity is only one element of success, and, however important it is to be dexterous operators, it is better still to be successful ones.

But it must not be supposed, that manual dexterity is to be undervalued—far from it. Manual dexterity is necessarily of the first advantage in the performance of any operation, and the Surgeon should diligently endeavor to acquire the Art of using his instruments with neatness, rapidity, and certainty. In many cases of minor moment, no other requisite is needed by the Surgeon than this. But it would, indeed, be a fatal error to suppose that, in the majority of cases requiring surgical interference, this is the only or indeed the chief requirement on the part of the operator. Manual dexterity must not be mistaken for surgical skill; and, desirable as it doubtless may be to be able to remove a limb, or to cut out a stone, with rapidity,—important, in a word, as it is to become a dexterous operator—it is of far greater importance to become a successful Surgeon. The object of every operation is the removal of some condition that either threatens life, or interferes with the comfort and utility of existence; and the more safely as well as certainly a Surgeon can accomplish this object, the better will he do his duty to his patients, and the more successful will he be in his practice. Success then, in the result of an operation, whether that result be the preservation of life or the removal of a source of discomfort, is the thing to aim at. To this, dexterity and rapidity in operating are in a high degree conducive; but there are various other considerations equally or still more necessary, the solution of which can only be afforded by an intimate general acquaintance with the Science of Surgery and of Medicine. The Diagnosis of the nature of the local disease, and of the extent of its connections, has to be made; lurking visceral affections must be detected and, if possible, removed The Constitution of the patient must be prepared; he must, as far as possible, be placed in those hygienic conditions which are most favorable to recovery; the best time for the performance of the operation must be seized; and, after its completion, the general health must be attended to in such a way as shall best carry the patient through the difficulties he has to encounter, and any sequelæ or complications that arise must be subjected to appropriate treatment. These, as well as the simple performance of the operation, are the duties of the Surgeon; and on the manner in which they are performed, as much as, or even perhaps

more than, on the mere manual dexterity displayed in the operation itself, will the fate of the patient depend. It is well known that the result of operations differs much in the practice of different Surgeons of acknowledged dexterity; and this variation in the proportionate number of recoveries cannot be accounted for by any difference in the degree of manual skill displayed in the operation itself, but must rather be sought in the greater attention that is paid by some Surgeons to the constitutional treatment of their patients before and after operation, and to their more perfect acquaintance with those general laws that influence the success of all the operations of Surgery. Indeed, success in Operative Surgery mainly depends on two conditions: 1. The selection of proper cases; that is to say, of cases in which alone an operation will probably be followed by a successful result; and 2, The avoidance or the combating of those deleterious influences, hygienic and others, to which a patient may be exposed after an operation, and which may directly mar its success.

Two requisites are thus essentially needed to constitute a successful operator. The first is, the possession of that mechanical skill that is required for the safe, efficient, and speedy performance of an operation; the second, of at least equal importance, is the scientific knowledge requisite to determine the cases in which operation has become necessary, in which it may be practised with a reasonable prospect of benefit and success, and to decide on the means to be adopted to place the patient in the most favorable circumstances for recovery.

The practice of operating in notoriously hopeless cases with the view of giving the patient what is called "a last chance" is much to be deprecated, and should never be followed. It is by operating in such circumstances, especially in cancerous diseases, that much discredit has resulted to Surgery; for in a great number of instances the patient's death is hastened by the procedure, which, instead of giving him a last chance, only causes him to be dispatched sooner than would otherwise have happened. It may be truly be said that a great surgical operation, in its conception, its performance, and its completion, tests the Surgeon's medical knowledge as much and in as varied a manner as it taxes his manual skill; and that, taken as a whole, it is the highest development of the medical art.

CONDITIONS INFLUENCING THE SUCCESS OF OPERATIONS.

The circumstances that mainly influence the result of an operation, so far as the recovery of the patient is concerned, may be arranged under three heads: 1. Those that are connected with the *State of the Patient's Gen ral Health* before and at the time of its performance; 2. The *Hygienic Conditions* by which he is surrounded after it is done; and 3. The *Special Dangers* connected with the operation itself.

1. All other circumstances being alike, the condition of a patient that principally determines the result of an operation is the **State of the General Health.** Indeed, success is influenced far more by the state of the patient's constitution than by the severity of an operation itself, or even by the mechanical dexterity with which the Surgeon performs it. Very often we see a patient carried off by fatal disease supervening on some extremely trifling operation, (such as the removal of a small encysted tumor,) which in itself ought in no way to endanger life, were it not that the patient's constitution was at the time of its performance in so unhealthy a state that the slightest exciting cause has been sufficient to call into activity fatal disease. So, also, it is no uncommon circum-

stance to see one patient sink after the most dexterously performed operation for hernia, or stone, the ligature of an artery, etc., owing to some morbid condition of the blood or of the system that disposes to low or diffuse inflammation; whilst another may possibly make the most remarkable and rapid recovery after he has been mutilated with but little skill. Independently of actual organic disease of the viscera, of which I shall hereafter speak, there are certain conditions of the body with respect to the condition of the nervous system, the circulation, and the general physical state, that exercise an injurious influence. Thus, persons of an irritable and anxious mind do not bear operations so well as those of a more tranquil mental constitution. Those also of a feeble and irritable habit of body, especially nervous and hysterical women, with but little strength of circulation, cannot bear up against severe surgical procedures, and often sink after comparatively slight ones; being apt to become depressed and exhausted, and to sink without rallying. Persons who are overloaded with fat are not good subjects for surgical operations. In them the circulation is usually feeble; the wound heals slowly and is apt to become sloughy; and intercurrent disease of a low type often sets in. Short of actual structural disease of important organs, as the lungs, heart, or kidneys, I know no condition more unfavorable to success after operations than premature or excessive obesity. In some states of the system the patient, although apparently in his usual health and not affected by any recognisable disease, may yet have the blood in so bad a state—so charged, perhaps, with morbid matters, that the least physical or even mental disturbance may call into activity the latent elements of mischief. It is in such conditions of the system as this that trivial operations, in themselves unattended by danger, such as the extirpation of a sebaceous cyst or the removal of a pile, may be followed by a severe, dangerous, and possibly fatal constitutional disturbance. The operation is the act that pulls the trigger and finally determines the explosion of previously stored-up materials of mischief.

Patients with a high temperature should never be operated on except for the relief of that very condition which occasions the elevation of temperature, such as the accumulation of pus, or in one of those four great surgical emergencies that demand under all and every circumstance immediate operation; viz.: 1, dangerous hæmorrhage; 2, impending asphyxia; 3, strangulated hernia; and 4, over-distended bladder. The urgency of these conditions, which may be termed the four classes of primary surgical urgency, overrides all other considerations.

An individual of a sound constitution, that has never been impaired by excesses of any kind, whose habits have been temperate and sober, whose diet has been sufficient and of good quality, whose mind has never been overstrained by the anxieties of business or the labors of a professional life, and whose existence has been spent in rural occupations and in the pure air of the country, is necessarily placed in a far more favorable position to bear the effects of any mutilation, whether it be the result of injury, or be inflicted by the Surgeon's knife, than the man whose physical powers are worn out by active and unceasing business avocations or professional work, whose nervous system is exhausted by his anxious labors; infinitely more so than the poor inhabitant of a large and densely peopled town, who has from earliest childhood inhaled an impure and fetid atmosphere, whose scanty diet has consisted of the refuse of the shops, or the semi-decomposed offal of the stalls, and whose nervous system has been irritated and at the same time exhausted in the

daily struggle for a precarious livelihood, or over-stimulated by habitual excesses in strong drinks, by which he has hoped to purchase temporary forgetfulness of the cares of a sordid life. Though individuals with such different antecedents be placed under exactly the same hygienic circumstances *after* the performance of an operation, yet the results will probably be very dissimilar, influenced as they must be by their past rather than by their present condition. In the one case, the inflammation resulting from the incision, and requisite for the cure of the wound, will not overstep the normal degree necessary for the healing process. In the other it may not attain to this, but, assuming a low and diffuse form, may terminate in some of those secondary affections which will presently be adverted to as occasioning death under unfavorable hygienic conditions.

Besides the general state of the patient's health, the *Condition of Important Organs* must be taken into consideration before an operation is decided on. The state of the patient's *Heart* should be carefully looked to. Valvular disease of this organ, if early or slight, need not be an obstacle to most operations, especially those of expediency. But fatty degeneration of the heart, as indicated by its feeble action, by irregularity and want of power in the circulation, by breathlessness, and by a distinctly marked arcus senilis, should make the Surgeon careful in undertaking any operation attended with much loss of blood or shock to the nervous system. Such a condition of heart is liable to occasion great depression of strength, syncope, and death—often sudden—some days after the operation. In cases of chronic disease that it would otherwise be proper to submit to operation, this condition of the heart becomes a serious obstacle. But it need not be a bar to operation in acute cases that would be speedily fatal if left to themselves, and certainly not in one of the four conditions of primary surgical urgency.

Disease of the *Lungs*, of a tuberculous character, when active or advanced, is incompatible with the success of an operation; but under certain circumstances, as will be explained when speaking of diseases of the joints and fistula in ano, an operation is justifiable and proper, even though the patient be consumptive.

If the *Liver* be diseased organically, if it be in a state of amyloid degeneration, or affected by cirrhosis, and more especially if any symptoms of ascites have supervened, no operation but for the relief of disease that instantly threatens life should be undertaken.

Perhaps the most serious constitutional affections, and those that more than any others militate against the success of an operation, are diseased *Kidneys*, with albuminuria and diabetes; in these conditions, the local inflammatory action that is set up is apt to run into a low, diffuse, and sloughing form, and this is especially the case in all operations about the pelvic and genito-urinary organs.

The contamination of the patient's system by Malignant Disease, must always prevent our operating, as a speedy return of the affection will most certainly take place. And, lastly, no operation, save of the most urgent necessity, in cases that fall within the category of one of the four classes of primary surgical urgency, and thus intended to rescue the patient from impending death, should ever be performed whilst he is laboring under Pyæmia, Septicæmia, Erysipelas, Phlebitis, or any Diffuse Inflammation; and even during the epidemic prevalence of these affections, operations that are not of immediate necessity should be postponed until a more favorable season. Operations in very old people, if severe and attended by much shock to the system, are commonly fatal;

amputations in individuals above the age of seventy, are very rarely successful.

2. **The Hygienic Conditions** to which a patient is exposed both before and after an operation, will most materially influence its results. These conditions are of two kinds :—1. As regards the diet of the patient, and 2. As concerns his exposure to a vitiated atmosphere contaminated by the emanations from the sick and wounded, such as is commonly met with in the wards of an overcrowded or ill-constructed hospital.[1]

The proper regulation of the patient's *Diet* before and after an operation is of great consequence. On this point it is impossible to lay down any very definite rule, as much depends not only on the patient's previous habits of life. but on the nature of the operation itself; and, as this subject will be discussed at the end of the chapter, it need not detain us here. It is not, however, often that in civil practice the insufficient quantity or the bad quality of the patient's food, with which he is supplied *after* the performance, influences materially the result of an operation. But in military and naval practice in time of war the case is far different. The soldier or the sailor on active service is often exposed to serious injuries that necessitate the more important operations at a time when his constitutional powers have already been broken down by scurvy, dysentery, or some other similar affection, resulting as much from the deficient quantity as from the unwholesome character of the food with which alone he can be supplied. And after the operation the only available nutriment may be of the coarsest character, possibly salted, and imperfectly cooked. In such circumstances operation-wounds do not heal, or they assume a peculiar gangrenous character; or the patient sinks from ulceration of the intestinal mucous membrane. The mortality of operations becomes enormously increased; and there can be little doubt that thousands of deaths which have occurred in wars between the most civilized nations and the best appointed armies may be attributed to these causes.

The *Hygienic Conditions* to which the patient is subjected after an operation will necessarily vary greatly according to the locality in and the circumstances under which it is performed—whether it is done in a private house, where the patient may be isolated, freed from the chance of all contamination, and surrounded by every sanitary precaution; or in a hospital, where he must necessarily be exposed to emanations possibly of a septic and infectious character from other patients, where the building may be impregnated by the exhalations from generations of sick and injured, and where sanitary measures may be neutralized by the conditions generated by a a vast assemblage of sick under one roof. Then, again, the circumstances in which a patient is placed after an operation for an accident of civil life are necessarily very different from those that surround one who is exposed to the peculiar perils that are necessarily connected with military hospitals and ambulances in time of active war, and which will be more fully described in the chapter on Gunshot-wounds.

In private practice, ill results may follow operations from three different causes, viz.: self-infection of the patient, in consequence of the retention of decomposing and putrescent secretions in the wound; conveyance of infection by the Surgeon; and general faulty sanitary arrangements of the house. In hospital practice these different sources of danger must

[1] I would refer the reader who wishes to study this very important subject more deeply to my "*Lectures on Hospitalism and the Causes of Death after Operations.*" Longmans, 1874.

necessarily exist to the same if not to a greater extent than in private. In hospital, however, just as in private practice, these particular dangers are all preventable, and disease of a septic character ought not to be allowed to generate itself through their medium. The frequency of such an occurrence is in the direct ratio of the want of hygienic attention bestowed upon the patient But in addition to these causes of disease, there exists in hospitals one special source of danger which leads to the excessive mortality that up to a recent period has prevailed in most of these institutions, and which unfortunately is still allowed to be prevalent in some. This danger results from the accumulation of large numbers of sick and injured people in one building.

Tyndall has shown that the atmosphere is loaded with minute particles of organic matter in a state of suspension. Other observers have proved microscopically that these particles vary under different conditions, and consist of the detritus of the solid materials that furnish them—necessarily varying in its composition according to the source whence it is derived. Parkes, who has examined the air of crowded buildings, such as military hospitals, barracks, &c., finds that it contains large quantities of epithelium from the skin and perhaps the mouth. He states that all the specific diseases may be caused by the presence of organic impurities floating in the air, and that whether these exist in the form of impalpable powder of moist or dried epithelium, or pus-cells, is a matter for future inquiry.[1] These are either absorbed by the lungs and skin, or the pulmonary and cutaneous surfaces are unable to set free their excreta in an atmosphere already surcharged ; the blood becomes thereby vitiated, and low, diffuse, or erysipelatous inflammations of all kinds, with pyæmia, septicæmia, or sloughing phagedæna, are the necessary consequences. In fact, these diseases may, if the term is allowable, be manufactured in any hospital or house, however clean and well situated, by the accumulation within it of too large a number of patients suffering from suppurating wounds. De Chaumont has analyzed the air of two of the London hospitals. Besides gaseous impurities in the form of free and albuminoid ammonia, organic oxygen, carbonic acid, nitric and nitrous acids, a quantity of solid matters suspended in the inspired air, on microscopical examination (562 D), these suspended particles were found to consist of a quantity of skin epidermis, of nucleated epithelium from the mouth, pus-cells, and minute bodies (Sphærobacteria), *in active motion*, besides a quantity of fibres of clothing.

The dust from the ward showed, under a power of 300 diameters, fibres of clothing, dyed and undyed, wood and vegetable tissue, soot and charred wood, epithelium, starch, a great deal of granular matter and spores of some kind; in fact, it was almost wholly organic. On the walls of one of the hospitals of Paris, Broca found pus-cells; and Nepveu discovered, in a similar locality, at another, micrococci in immense numbers, microbacteria, epithelium, pus cells, and red corpuscles. These facts, which might be greatly extended, prove that hospital air is, under ordinary circumstances, loaded with, and the walls covered by, organic matters, often in a state of activity. These are germs of those diseases which are the scourges of hospitals—the prevalence of which is alike the evidence and the measure of their insalubrity, which are preventable by improved hygienic arrangements, and which, doubtless, will be prevented when once it is recognized that they are not necessary and unavoidable evils.

[1] "Manual of Practical Hygiene," pp. 88, 99, 106. 1869.

These facts are abundantly proved by the experience of all military surgeons; and I have had occasion to notice them in ordinary hospital practice. It has been found in the wards of University College Hospital that, if the number of patients suffering from suppurating wounds exceeds a certain proportion of the cases, septic disease will inevitably be engendered.

Overcrowding of patients after operations is thus one of the most fertile causes of disease and death; for the overcrowding of wounded people, whether the wounds be accidental or surgical, will inevitably produce one of the four septic diseases—phagedæna, septicæmia, pyæmia, or erysipelas. When the word "*overcrowding*" is used in connection with surgical hygiene, it does not mean the heaping together of the sick and wounded in one building beyond what it is intended to hold; but it means the accumulation in one ward or under one roof of a greater number of patients than is compatible with such purity of air as to render the septic poison incapable of development or of propagation in it.

The two great conditions to be attended to in the prevention of overcrowding are:—(1) Sufficient cubic space for each patient; and (2) an efficient system of ventilation. Both conditions are equally necessary. The *space* afforded to each patient in the surgical ward of an hospital where patients with suppurating wounds are mixed with others suffering from such injuries as simple fractures, unattended by breach of surface, should be at least 1500 cubic feet, and this should be changed by ventilation, once, if not twice, in the hour. If the proportion of simple cases be great, less than this may be safe; but if the majority of the patients have suppurating wounds, more space, as much as 2000 cubic feet, must be allowed. Whenever we have had an outbreak of the low surgical diseases—of erysipelas, sloughing phagedæna, or pyæmia—in the wards at University College Hospital, it has been owing to the accidental and, perhaps, unavoidable accumulation of a large number of serious injuries or of operation-cases in one ward, so that, although the cubic space for each patient remained the same as usual, it became inadequate owing to the peculiar gravity of the cases. It is then the nature of the injuries and diseases rather than the mere number of the patients that vitiates the air of a ward. Not only, however, is *space* required, but *change of air*, by proper *ventilation*, is equally needful. For, however large the cubic space for patients, the air, if not changed rapidly enough, soon becomes loaded with animal exhalations, and highly insalubrious. Hence care should be taken that a free current of pure air through the ward be maintained day and night. It is from want of this precaution during night especially that much mischief often results. It is useless to have wards too high in proportion to the floor space. The effective height of a ward to reckon for purposes of ventilation does not exceed 12 ft. Each surgical bed should have at least from 120 to 150 square feet of floor-space; and the air of a surgical ward should be changed about three times in the hour, giving each patient about 5000 cubic feet of air per hour. The importance of maintaining efficient ventilation during night, and the little danger to be apprehended from the admission of cold night air, have been so forcibly pointed out by Miss Nightingale in her *Notes on Nursing*, and are now so universally admitted, that I need not do more than add the testimony of my experience to the truth of her observations. In cold weather, also, there is so great a disposition on the part of nurses and patients to shut up wards and rooms, that the air becomes close, oppressive, and contaminated; and hence it is that the erysipelatous and miasmatic

diseases are so rife during winter and early spring. The "East Wind" is commonly accused of being the cause of these; and no doubt it is so, but only indirectly, by causing windows and doors to be shut, so as to exclude the cold that usually accompanies that wind, and thus rendering the atmosphere impure. It is impossible to over-estimate the importance of a free supply of pure air in lessening the mortality after operations, not only in hospitals, but equally in private dwellings. The fact has often been observed in military practice, and the recent Franco-German War brought it into strong relief—that those wounded fare best who are treated in open huts or tents, whilst those who are placed in the apparently more favorable conditions afforded by regular houses become decimated by those scourges of military surgical practice, pyæmia and hospital gangrene. It is the difference in the hygienic arrangements in different hospitals that more than any other condition influences the varying rate of mortality in different institutions; and it is obvious that, *cæteris paribus*, those patients will have the best prospect of recovery who are most scrupulously attended to in this respect; that no cases of operation should be placed in ill-ventilated wards, or in those that contain more than a certain percentage of patients with suppurating wounds; and that the performance of operations in close and ill-ventilated rooms, or in houses situated in overcrowded neighborhoods, should, as far as possible, be avoided.

The mortality arising from inattention to these various hygienic conditions is not a necessity of the operation, but rises or falls according as the circumstances in which the patient is placed depart more or less widely from those conditions that are necessary to the maintenance of health. It is by the induction of pyæmia and of the erysipelatous inflammations, with fever of a low type, that the neglect of the hygienic conditions of operated patients destroys life. The prevalence of these diseases in an institution is the measure of, and in direct proportion to, the neglect of the sanitary arrangements in it. These diseases are preventable and ought to be prevented. Surely the first and more essential requisite of a hospital should be that it is not a source of disease to its inmates—that those who are compelled to seek its aid do not suffer from its effects.

The faulty hygienic conditions that are still too frequently met with in hospitals are alike a cruelty to the patient and an injustice to the Surgeon. The cruelty to the patient consists not only in exposing him to an increased chance of death—or as it is commonly termed "to a higher rate of mortality" from septic diseases that are preventable, and that are the direct outcome of the defective hygienic arrangements of the institution—but in subjecting him to a prolonged and imperfect convalescence, either or both of which conditions may be taken as a measure of the neglect of sanitary arrangements in a hospital.

But want of attention to sanitary hospital arrangement is equally an injustice to the Surgeon. His reputation suffers by an increased rate of mortality amongst his patients from causes which, though preventable, are altogether beyond the sphere of his control; an undue burden of anxiety, responsibility, and of care is thrown upon him by the necessity under which he lies of waging a constant warfare against septic hospital influences. If it were not for erysipelas, pyæmia, septicæmia, and "blood-poisoning" in its protean forms, the duties of a hospital Surgeon would be comparatively light. In order to combat these pernicious influences, he is driven to the employment of elaborate, complicated, and expensive methods of "Antiseptic" treatment with the view of destroying those

septic germs which, conveyed by the air and implanted on the wound, act as poison to its tissues and ferments to its fluids. He is compelled to accomplish by artificial means those results which the architects and managers of hospitals ought to secure by proper attention to the construction of the building, its ventilation, and general management. If hospital hygiene were properly understood and efficiently practised, those foul and filth-begotten diseases, pyæmia and hospital gangrene, would disappear, and "antiseptics," in the absence of septic influences, would become unnecessary. Under the present system we begin at the wrong end. Instead of preventing the development of septic contaminations by proper hygienic arrangements, we allow the pollution to take place, and then attempt to prevent infection of the wound by ingeniously devised methods of protection, and by destroying the impurities in the septic-laden atmosphere by means of chemical agents. In fact, cleanliness in its broadest sense is the best and most efficient "antiseptic"; where it exists none other is needed. It is superior to all chemical antiseptics in this, that it prevents the development of the septic poisons, instead of allowing them to be generated and then destroying them.

The exposure of a patient after an operation to the *contagious emanations* of septic diseases from other sick or wounded patients, is attended by the most fatal consequences. Whenever it is practicable, every case of septic disease, such as pyæmia, erysipelas, inflamed absorbents or veins, or hospital gangrene, should be rigorously excluded from the ward or room in which other patients with operation-wounds happen to be lying; and, if possible, the same nurses, dressers, or surgeons should not be allowed to go from the infected to the healthy, nor should the same appliances, dressings, or sponges be used for both. Great care also should be taken in the purification of the bedding that has been used by patients suffering from septic disease; the blankets especially are apt to harbor infection long, and must be thoroughly purified. Every hospital Surgeon must have had abundant occasion to deplore many deaths after operation, arising from preventable causes due to want of attention to these simple precautions.

Attention to hospital hygiene is by no means of so modern a date as many might be led to suppose. The Surgeons of the last century paid great attention to it, and their success was proportionately great. Thus Alanson's success in amputations has never been surpassed, and rarely, if ever, equalled even by the aid of antiseptics and of every modern chemical and mechanical appliance. Writing in 1782 ("Alanson on Amputation and the After-treatment." London, 1782), he says (Preface, p. 15), that he amputated in thirty-five cases, such as promiscuously occurred in the Liverpool Infirmary, *without the loss of a single patient.* The symptomatic fever was slight, and there was not an instance of secondary hemorrhage in the whole series. Can these results be equalled now? I doubt it much. But Alanson was a sanitary reformer in his day; and had his instructions been followed, thousands of lives would have been saved which have since his time been wantonly sacrificed by the neglect of hygienic measures. His advice is so practical that it deserves the attentive study of the modern Surgeon. He says: "The air in which the case is to be conducted is a point worthy of your greatest attention: if possible, the room should be spacious, and in an open wholesome situation. It is well known that in hospitals which are situated in populous towns and are much crowded, the salutary influence of the air is so altered, that compound fractures and other

important surgical cases prove peculiarly fatal, and that such fractures may almost certainly be cured in the country." . . .

"The operation of amputation done in the country, as above described, will be followed almost certainly with a speedy cure; there the consequent symptoms are trifling, nearly the whole internal surface of the wound unites by the first intention, the suppuration consequently is small." . . .

"Many hospitals are so tainted by unwholesome effluvia that they are rather a pest than a relief to the objects they contain." (Op. cit., p. 89–92.)

Then follow sixteen distinct paragraphs or heads of the most useful sanitary advice, which "are humbly recommended to those who have the care of hospitals in want of such attention."

This code of regulations deserves careful study. In it Alanson advises:

That no ward should be inhabited for more than four months at a time; that it be cleansed, whitewashed, and purified. That the "bedstocks" be of iron; the bedding frequently changed, and made of inexpensive materials so that it may easily be renewed; and that when the weather admits, it be exposed to the open air for several hours a day. That dirty patients be stripped of their clothing before admission; that they have a warm bath and then be clothed in dresses provided by the hospital. That the infected clothes be baked in a properly constructed oven. That newly admitted patients be put into clean, well-ventilated wards. That all incurable and infectious cases, and especially chronically ulcerated legs, be refused admission. That offensive gangrenous and putrid sores be placed in distinct rooms, and not suffered to infect a whole ward. That there should be particular rooms provided for patients who have undergone operations; that they should be airy, never long inhabited, and afterwards cleansed and ventilated. That a hospital should never be crowded *on any account*, and always so large that a part may be uninhabited. That the windows be opened for a certain number of hours daily. And lastly, that every hospital should have a "house in the country," in other words, a "convalescent home," attached to it. Modern science has enabled to determine by the microscope and the test-tube the true nature of those conditions that lead to hospital infection, but sanitary practice has not as yet gone in advance of the admirable precepts laid down by Alanson a century ago.

3. The **Special Conditions directly excited by the Operation itself**, predisposed to by the circumstances that we have just been considering, and which commonly lead to a fatal result, of which they are the immediate occasion, are the following:—Shock, Exhaustion, Hæmorrhage, Gangrene, Tetanus, Pyæmia, Septicæmia, and the various Low, Diffuse, and Erysipelatous Inflammations. These causes of death are so various, and comprise so many distinct diseases, that I shall do little more here than mention them; referring the reader to the different chapters in the body of the work, in which each is specially treated.

The *Shock of an Operation* may prove fatal in various ways: from the severity of the mutilation, as in a case of double amputation; from the nervous centres being implicated, as in the removal from the face of large tumors that have connections with the base of the skull; from fear, or from the state of nervous depression, into which the patient has previously fallen, causing him to feel the influence of an operation disproportionately to its severity. These various effects of shock have, however, been much lessened since anæsthetics have been generally administered

in operative surgery. Anæsthesia, however, does not remove the physical impression produced on the system by a severe mutilation; hence the influence of a serious and prolonged operation is still manifested in the production of shock, of collapse, and of slow recovery, even though the patient have suffered no actual pain. Certain operations appear to exercise a peculiar depressing effect on the nervous system, even though no pain be experienced. Thus, in castration, at the moment of the division of the spermatic cord, the pulse will sink markedly, even though the patient have been fully anæsthetized. So much is this the case, that it is well at that moment to suspend the administration of the anæsthetic.

Exhaustion, without any tangible local or constitutional disease, is an occasional cause of death after severe operations; more particularly in delicate females, in feeble or debilitated subjects, in those who have lost much blood, or who have become weakened by protracted suppuration.

Hæmorrhage, if very copious, may destroy the patient by inducing syncope that may be immediately fatal; or by increasing the influence of the shock so that he cannot rally; or it may be followed by serious after-consequences, such as the supervention of hemorrhagic or irritative fever, and a disposition to the occurrence of low and erysipelatous inflammations. During the performance of an operation, hæmorrhage should, as much as possible, be prevented; the operation itself is a cause of depression, and any great loss of blood not only seriously aggravates this, but disposes to the after-occurrence of pyæmia and low inflammations. It is in these secondary and indirect effects that the great danger of excessive hemorrhage lies. Blood is a very complex fluid; if once lost it is not easily replaced, more especially in advanced years. At any period of life, its excessive loss may permanently impair the constitutional powers. Patients who have lost much blood make slow recoveries, often interrupted by intercurrent diseases; and not unfrequently die at the end of two or three weeks, from some asthenic visceral complication. In fact, it is in this way, rather than from its immediately dangerous consequences, that the loss of a large quantity of blood at an operation proves injurious to the patient. When hæmorrhage occurs a few hours, or a day or two, after an operation it usually proceeds from imperfect ligature of the vessels, or from arteries bleeding after the setting-in of reaction, which had not furnished blood whilst the patient was under the influence of the shock of operation. On recovery from anæsthesia also, it not unfrequently happens that arteries begin to spout, which yielded little or no blood whilst the patient was in a state of anæsthesia. In these circumstances, hæmorrhage is of far less moment, and less frequently fatal, than when it occurs at a later period, in consequence of some morbid condition of the wound or system, and usually in association with an asthenic state, by which the proper formation of plastic matter is interfered with.

Gangrene is not a common cause of death after operations, except in the phagedænic form in military practice in time of war. When it occurs in civil hospital practice, it is the result, in most cases, of faulty but preventable hygienic conditions, and its frequency in any institution is the direct measure of, and of itself a conclusive proof of, neglected or defective sanitary arrangements. In the local form it may, however, occur without being the result of want of hygienic precautions, but from purely local conditions, as in a limb from excessive traumatic violence, or in a strangulated hernia in consequence of excessive strangulation of the gut before operation.

Tetanus but rarely occasions death after operations in this country.

When it does occur, it is more frequently after the lesser than after the greater operations that it developes itself.

Internal Inflammations of an acute and active character may carry off the patient after an operation in two ways. Inflammation of this kind may have existed antecedently to the operation, being the disease for which it is performed; and, being unchecked by the operation, may continue its course and destroy life. Thus, when a child dies after tracheotomy for croup, death is not in general occasioned by the operation, but by the extension into the lungs of the disease for which it has been performed. Or the inflammation may be the necessary and direct consequence of the operation; as when peritonitis occurs after the operation for strangulated hernia, or arachnitis after the skull has been trephined. But it is not by the action of any of these direct results that an operation usually proves fatal. In the great majority of instances, death is occasioned in a more indirect manner by the development of pyæmic or erysipelatous inflammations, to which a neglect of hygienic laws acts as a powerful predisposing cause.

Septic disease, in one or other of its forms, is certainly the most frequent cause of death after operations, more particularly in large towns. It is especially and directly predisposed to by the neglect of hygienic laws by the patient previously to the operation, and by the unfavorable sanitary conditions by which he may be surrounded after its performance. Closely allied to pyæmia and septicæmia, frequently co-existing with them, having the same predisposing causes, and associated with febrile disturbance of an asthenic type, are the various *low and diffuse inflammations*, whether assuming the form of erysipelas, of phlebitis, or of inflammation of the absorbents, which are the dread of surgeons and the scourge of hospitals. It is to pyæmia, and to these various allied erysipelatous and low inflammations, with their attendant asthenic constitutional disturbance, that at least three-fourths of the deaths after operations are due. It is in the production of these diseases that an impure blood, loaded with effete materials retained through habitual disregard of the ordinary rules of health, or through defective elimination by the kidneys and skin, acts as a potent predisposing cause, requiring but some injury or wound to call into activity a most dangerous amount of local inflammation and of constitutional disturbance. In these circumstances, it is not the extent or size of the wound that determines the dangerous results. The mere fact of a breach of surface, however trivial, is sufficient to excite these morbid processes, the materials for which have been previously stored up in the system. In such conditions of the system, the amputation of a toe may be as fatal as that of the thigh, or the removal of a small atheromatous cyst of the scalp as the ablation of the breast; the additional danger essentially connected with the greater operations being the only increased risk from shock and hæmorrhage.

Diphtheritic Inflammation may develope in a wound with or without concomitant throat-affection. It may be developed by direct contagion, or under the influence of those local epidemics or constitutional influences that cause diphtheria to appear in the fauces. When a wound becomes affected in this way, the edges and the integument for some little distance around are swollen, brawny, and of a deep red color; the surface of the wound is covered with a grayish white exudation which cannot be cleaned off; the skin nearest to the wound also becomes besmeared with tenacious creamy-looking exudation matter; and febrile symptoms of a low type develope themselves.

PREPARATION FOR OPERATION.

The Surgeon, being convinced of the necessity of having recourse to operation, should fully and unreservedly lay before his patient the state of the case, and, if necessary, give the reasons that render an operation imperative, in order to obtain his consent and that of his family. In the event of the patient refusing to submit, what course should the Surgeon pursue? In this he must be guided partly by the nature of the proposed operation; and partly by the state of the patient, and his capability of forming a correct judgment of his case. If the operation be one of expediency, merely for the relief of an infirmity or the removal of an ailment which does not directly jeopardise life, most certainly no Surgeon would think of undertaking it without the full consent of his patient. If, on the other hand, it be an operation that is imperatively necessary for the presevation of life, in which the delay of a few minutes or hours may be fatal to the patient, as in one of the four cases of extreme surgical urgency, viz., dangerous hæmorrhage, asphyxia, over-distended bladder, or strangulated hernia, and where the patient, unaware of, or incapable of being made to understand, the necessity for immediate action, is unwilling to assent to the proposal, the Surgeon will truly be placed in a dilemma of anxious responsibility; between allowing the patient to fall a sacrifice to his obstinacy, ignorance, or timidity, and attempting, perhaps unsuccessfully, to rescue him from inevitable death against his own consent. I believe the proper course for the Surgeon to pursue under such circumstances, is to judge for the patient in a matter on which he is clearly unable to form an opinion, and to compel him, so far as is legal and practicable, to submit to the necessary steps for the preservation of his life, or to put him under anæsthetics, and, when he is unconscious, to perform any operation that may be necessary. In the event of the patient being insensible, as after an injury of the head, the Surgeon must necessarily take upon himself to act as the case requires. Children cannot be considered capable of giving an opinion as to the propriety of an operation; the consent of the parents is here necessary, and quite sufficient; and, in their absence, the case being an urgent one, the Surgeon must stand *in loco parentis*, and take all responsibility upon himself.

These points then having been determined, the patient should, if possible, be *Prepared for the Operation*. In a great number of cases requiring operation, as in strangulated hernia, bad compound fracture, etc., no time is allowed for preparation, but the Surgeon must at once submit the patient to the knife, whatever the state of his constitution may be. But in the more chronic cases, time is given for improving the constitution. This preparation must not consist in any routine system of purging and starving, which is ill calculated to support the constitution against the call that will be made upon its powers; nor, on the other hand, in blindly adopting a tonic or stimulating regimen, which may produce fever, and irritate the constitution; but in adapting our means to the condition of the patient and the nature of the operation to be performed. The tendency to erysipelas, pyæmia, and low and diffuse inflammations generally, is materially lessened by supporting the patient's strength, by means of a nutritious diet, previously to the performance of the operation. Indeed, in many of the more severe injuries and surgical diseases, it is only by the use of a nutritious diet, and by the administration of tonics, quinine, or iron, and stimulants, often in large quantities, that the patient can be brought into a condition to bear the

shock and consequent depression of the operation. This is more particularly the case with hospital patients of bad constitution, who have met with serious accidents, attended by much suppuration and irritative fever. In the more chronic cases, the time should be seized for the operation when the temperature of the body is not too high, the secretions are free, the tongue clean, and the action of the skin and kidneys in a healthy state; and, above all, the mind should be kept tranquil and hopeful, being allowed to dwell as little as possible upon the impending event. In many operations, as those on the rectum and urinary organs, or in those of a plastic character, special modes of preparation are required, which will be discussed when we come to treat of the operations in detail.

The *Immediate Preparations* for the operation should always be superintended by the Surgeon himself. He must see that the table is solid, and of a convenient height, well covered with blankets, and provided with pillows; and that the light of the room is good. There must be a sufficient supply of sponges and of basins, with hot and cold water; and, if the operation be likely to be attended by much hæmorrhage, a tray filled with sand or saw-dust should be provided, in order to catch the blood. The Surgeon must then look over his instruments, comparing them, if the operation be complicated, with a list previously made out; he must see that they are arranged in the order in which they are wanted, and properly covered with a towel. Much of the successful performance of an operation depends on the attention and steadiness of the assistants. Of these there should be enough, but not too many. In all capital operations three or four will be required; one for the administration of the anæsthetic, another to command the artery, a third immediately to assist the Surgeon, and the fourth to hand sponges, instruments, etc. The duties of the assistants should be performed in silence, and each man must carefully attend to his own business, and not neglect this, as is too often done, in his anxiety to crane over and see what the Surgeon is about. There should be no unnecessary talking when once the patient is on the table; the Surgeon's directions ought to be conveyed by a brief word or two, by a look, or by a sign with the hand.

The Surgeon himself must always feel the heavy responsibility that hangs over him during the performance of a great operation—"at that moment when," as Dr. Grant has elegantly said, "Death everywhere surrounds his knife as he is endeavoring to convey all his knowledge to its point." But having carefully considered each successive step of the operation, provided for every emergency that can by any possibility arise in the cause of it, and trusting in Him, from whom all knowledge is derived, to strengthen his judgment and guide his hand aright, he will proceed to the performance of his duty with self-reliance, and in the full confidence of being able to effect all that Art can accomplish.

EMPLOYMENT OF ANÆSTHETICS.

It is reasonable to believe that the prevention of pain in surgical operations has been an object of solicitude to Surgeon as well as to patient from the earliest ages: and there can be little doubt that narcotics of various kinds have at different times been employed with this view. But the effect of these was so uncertain—their after-consequences perhaps so injurious—that no permanent reliance was placed upon them. The first endeavor to induce anæsthesia by the inhalation of vapors is stated to have been made in the thirteenth century by Theodoric, who recommended

that a "Spongia Somnifera," impregnated with spirituous extracts of various narcotic substances, should be held to the nostrils till sleep was induced; and after the operation the patient should be roused by the use of vinegar or fenugreek. It was not, however, till the commencement of this century that any serious attempts were made in this direction. The discovery of the remarkable properties exercised on the nervous system by the inhalation of nitrous oxide, then led Sir Humphry Davy and others to entertain hopes that it might be used as a means of relieving pain during surgical operations. Experiments were made with the gas with this view, but they did not prove altogether satisfactory, and it was abandoned, except as a means of amusement.

It is needless to do more than allude to such means as the compression of the nerves of the limb, as recommended by Moore—the employment of excessive venesection, as adopted by Wardrop—or the production of insensibility by mesmerism by Esdaile and others. These means of inducing anæsthesia were either inefficient, dangerous, or chimerical.

It was not until 1844 that a serious attempt was again made to introduce insensibility by inhalation during operations: and to the Americans is undoubtedly due the honor of having established the practice of Anæsthesia in Surgery. In that year Horace Wells, a dentist of Hartford, Connecticut, inhaled the nitrous oxide gas with the view of rendering himself insensible during the extraction of a tooth; and, finding the experiment succeed, repeated it on several of his patients. Its success was not, however, permanent; and having failed in several cases, he seems to have given up the attempt. In 1846 Dr. Morton, a dentist, and a pupil of Wells, used the vapor of ether instead of the nitrous oxide gas; and, having succeeded in extracting several teeth painlessly, applied to the authorities of the Massachusetts General Hospital at Boston for permission to administer it to a man from whom Dr. J. C. Warren was about to remove a tumor of the neck. The result was most successful. The news of this great discovery was immediately sent to England, where the first operations on patients anæsthetised by the inhalation of the vapor of ether, were performed at the University College Hospital by Liston, who amputated a thigh and tore out an ingrowing toe-nail without any suffering to the patient. At these operations I was present; they were performed on Dec. 22, 1846; and from that time the use of anæsthetics have been established in surgical practice in every civilised country.

For more than a year, sulphuric ether was the only agent habitually used for inducing anæsthesia. But during the whole of this period many professional men were busy with experiments on the anæsthetic influence of various kinds of vapors; and in November, 1847, Professor Simpson, of Edinburgh, published an account of the anæsthetic properties of chloroform. In this country this agent soon came to be generally employed, although ether held its ground with the American surgeons, by many of whom it is preferred to chloroform at the present time.

The employment of *Anæsthetics* in Surgery is undoubtedly one of the greatest boons ever conferred upon mankind. To the patient it is invaluable in preventing the occurrence of pain, and to the Surgeon in relieving him from the distress of inflicting it. Anæsthesia is not, however, an unmixed good. Every agent by which it can be induced produces a powerful impression on the system, and may occasion dangerous consequences when too freely or carelessly given; and even with every possible care, it appears certain that the inhalation of any anæsthetic agent is in some cases almost inevitably fatal. We cannot purchase immunity from suffering without incurring a certain degree of risk from

the very agent which gives us ease. There can, however, be little doubt that many of the deaths that have followed the inhalation of Anæsthetics have resulted from want of knowledge or of due care on the part of the administrators. Yet, whatever precautions be taken, there is reason to fear that a fatal result must occasionally happen. This immediate risk, which is but very small, is more than counterbalanced by the immunity from other dangers which used formerly to occur during operations.

There is, however, another question in relation to Anæsthetics which deserves the most serious consideration on the part of the Surgeon; viz., Do they influence the rate of mortality after operations? On this point there is conflicting testimony. Simpson has published statistics to show that the mortality after operations has lessened since the introduction of chloroform. J. Arnott, on the other hand, adduces figures to prove that it has materially increased, in amputation by 12, in lithotomy by as much as 28 per cent. I am inclined to believe that the rate of mortality has increased since the use of Anæsthstics in operative Surgery. But is this increase altogether, or indeed to any degree, due to any effect produced on the system by the inhalation of Anæsthetics? Is it not in reality rather the indirect than the direct results of the employment of Anæsthetics? May it not, in some measure at least, be owing to operations being often performed in very doubtful or extreme cases, now that they can be done painlessly, when formerly the suffering inflicted would have deterred the Surgeon from proposing, or the patient from acceding to, their performance? A surgical operation was formerly, from the pain attending it, looked upon as a more serious affair than it is at the present day, and surgeons were not willing to inflict suffering unless there were a good prospect of a successful issue. Now, however, that the most serious operations can be performed without any consciousness of suffering, the Surgeon, in his anxiety to give his patient a chance of life, may not unfrequently operate for disease or injury that would otherwise necessarily and speedily be fatal, and which formerly would have been left without an attempt at relief. But there is another cause that may account for this increased rate of mortality. During the last thirty years, the actual number of operations performed in hospitals has enormously increased, and probably in a great measure owing to the employment of anæsthetics. Hence hospital wards have become more crowded than formerly with severe operation-cases, and the causes of septic diseases have become much more rife, those diseases more frequent, and the mortality proportionately augmented.

Making, however, all allowance for the extension of operative Surgery to extreme cases that were formerly not thought to come within its range, I cannot but think that chloroform does exercise a noxious influence on the constitution, and does lessen the prospect of recovery in certain states of the system, more especially when the blood is in an unhealthy state. In such circumstances, the depressing influence of chloroform appears to me to act injuriously; the patient does not rally well after the operation, and immunity from suffering is purchased by a lessened chance of recovery.

Anæsthesia by the Administration of Chloroform is best commenced before the patient leaves his bed. The chloroform should never be given but by a person accustomed to its use, and on whose capability the Surgeon has full reliance; as nothing is more embarrassing during an operation, than to have any doubt about the chloroform being properly administered. Chloroform may be administered in many different ways, either on lint or on a handkerchief, or through an inhaler of

some kind. The following is the way in which chloroform may most safely be given on lint or a handkerchief, without apparatus of any kind. On a piece of folded lint, about two inches square, and consisting of three doubles, about a drachm of chloroform is poured; and the lint is then held at a distance of about three inches from the nose of the patient, so as to permit a very free admixture of air with the first few inhalations of the vapor. After the lapse of about half a minute, the lint is brought nearer to the patient's nose, to within a distance of perhaps an inch, being never allowed to touch; at the same time a porous towel, not doubled, is lightly laid over the face of the patient and the hand of the operator, so as to prevent the escape of the chloroform-vapor, but not to interfere with the admission of air. During the whole time, it is the duty of the administrator to keep his hand on the pulse, to watch the breathing, and occasionally to examine the pupils of the patient.

The method just described answers well enough in most cases, but it affords no means of ascertaining the proportion of chloroform in the air which is being inhaled by the patient. The administrator can judge only by the effects produced. There is a danger of the patient's lungs being filled with a very strong mixture at the moment when the signs of an overdose are first perceived. In the most favorable circumstances, it requires several respirations to replace the strong dose by fresh air; but if the patient happen to be in a rigid state, or his glottis be closed by spasm, considerable delay will occur, during which time, if the dose have not been strong enough to arrest the action of the heart, the blood is passing through the lungs and becoming further charged with chloroform.

Various inhalers have been contrived for the purpose of regulating the proportion of chloroform with accuracy. The simplest kind consists of a mask covering the nose and mouth, with a box for sponge or blotting-paper on which the chloroform is poured, and with valves to prevent the expired air from passing through the chloroform-chamber. The objection to this form is, that it yields a very strong mixture at first; and, when the chloroform has half evaporated, the remainder is so cooled that it evaporates too slowly to yield enough chloroform to insure the quietude of the patient, especially if he should move his head about so as to get a small quantity of air between his face and the mouth-piece.

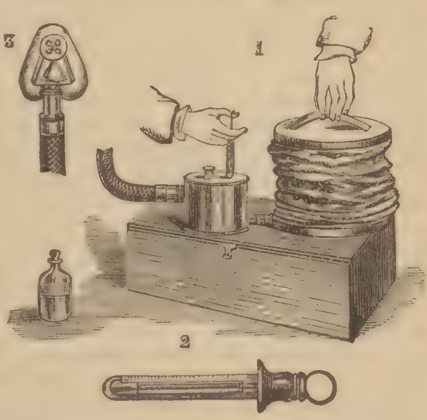


Fig. 1.—Clover's Chloroform Apparatus.

Snow improved this apparatus by surrounding the chloroform-chamber with water, and also making the upper valve movable, so that at the beginning of the inhalation only a portion of the inspired air should pass over the chloroform. This was a great improvement; but accuracy was not secured, because the proportion of chloroform given up varies with the temperature of the room, with the slowness or rapidity of the patient's breathing, and with the cooling of the chloroform, which is not entirely prevented by the water-jacket.

Clover has devised an apparatus, consisting of a bag holding 8000 cubic inches of air, which is suspended from the coat-collar at the back of the administrator, and connected with the face-piece by a flexible tube (Fig. 2). The bag is charged by means of a bellows (Fig. 1, 1) measuring 1000 cubic inches; and the air is passed through a box warmed with hot water, into which is introduced, at each filling of the bellows, as much chloroform as is required for 1000 cubic inches of air. This is done with a graduated glass syringe (Fig. 1, 2) adjusted by a screw on the piston-rod to take up no more than the quantity determined on, which is usually from 30 to 40 minims. When the bag is full enough, the tube is removed from the evaporating vessel, and the mouthpiece (Fig. 1, 3) adapted to it. The patient cannot get a stronger dose than the bag is charged with; but the proportion can be made any degree weaker, by regulating the size of an opening in the mouthpiece, which admits additional air.

Fig. 2.—Administration of Chloroform by Clover's Apparatus.

The result of Clover's experience with this instrument is of the most favorable character. He has administered this anæsthetic in many thousand cases without an accident of any kind.

The principal points to be attended to during the inhalation of this potent agent are, that it be not given too suddenly, or in too concentrated a form; and that, whilst under its influence, the patient be not raised into the erect or sitting position. If lint be used, it may be too much saturated, and be held too closely applied to the mouth and nostrils; and the patient will not be able to get sufficient air, and may speedily become partially asphyxiated, choking violently, struggling to get free, and becoming purple in the face, with a full slow pulse. Care should be taken not to compress the abdomen in holding the patient; for, as the respiration becomes chiefly or wholly diaphragmatic, it may be seriously interrupted by any pressure on the abdominal wall. Whilst under the influence of chloroform, the patient should never be raised up, as has just been stated; for, as this agent exercises a powerful sedative action on the heart, sudden and perhaps fatal syncope may ensue from putting the patient into the erect position. Hence, also, it is dangerous to administer it in those operations that require to be performed whilst the patient is erect. It is well to caution the patient not to take anything to eat for three or four hours before its administration, lest it induce vomiting of the partially digested meal. With due caution, it may be given with perfect safety to individuals of all ages. I have operated on infants less than a week old, as well as on octogenarians, under its influence. In administering it to young children, Snow recommends its dilution with rectified spirit, but this is unnecessary.

The first influence of chloroform appears to be exercised upon the nervous system. The patient becomes excited and talkative, and a state of unconsciousness is induced, the muscular system at the same time being rendered rigid and tense. At this time the heart's action is usu-

ally quickened, and more forcible than natural. As the administration of the chloroform continues, however, complete paralysis of sensation and motion is induced. The patient becomes altogether unconscious to all external impressions, the muscles become relaxed, and the action of the heart slow and feeble. This diminution in the power of the heart's action is well marked in the lessened force of the jet of blood from cut arteries. The respirations become shallow and feeble, in proportion as the sensibility of the nervous system and the energy of the muscular movements are lessened, and the blood in the arteries becomes dark; in fact, a semi-asphyxial state sets in. When thus fully anæsthetised, the patient is undoubtedly on the very verge of death, and requires the most careful watching by the person who administers the chloroform; his fingers should never be off the pulse, nor his eyes taken away from the countenance of the patient. The breathing should be very carefully observed: when it becomes embarrassed chloroform must be given sparingly, and when it becomes stertorous it should be discontinued entirely. In this state, the inhalation of a small additional quantity of this potent agent, the application of the vapor in too concentrated a state, or the sudden rising up of the patient, might occasion death from paralysis of the heart.

If the inhalation of chloroform have been suspended, great care should be taken when its administration is recommended, lest the already enfeebled heart be entirely overpowered by the influence of too large a volume of vapor suddenly given in a concentrated form.

It should be borne in mind that it is not necessary in all operations to administer chloroform to the same extent. In all the greater operations, as amputations, lithotomy, and the ligature of arteries, enough should be given to completely paralyse muscular movement, as well as to suspend sensibility and consciousness. In operations for hernia, also and all other proceedings implicating the abdominal walls, if complete muscular relaxation be not induced, great inconvenience and not a little danger may result. So, also, in very painful operations about the anus and genital organs, a full dose of chloroform should be given. But for the removal of many tumors about the trunk, or in many of the minor operations on the extremities and about the head and face, muscular relaxation is not necessary; and it will be sufficient to give enough chloroform merely to suspend sensibility and consciousness to pain.

In certain diseased conditions of the system the administration of chloroform requires much care; but, as a general rule, it may be stated that, whenever the constitutional disease has not advanced to such a degree as to contraindicate an operation, chloroform may be given. In the early stages of phthisis it may usually be safely inhaled; but in some cases of bronchial irritation, the vapor is apt to produce troublesome cough. When the heart is diseased, great caution is necessary, more particularly when its muscular substance has undergone fatty degeneration; the sedative influence of the chloroform being apt, in these circumstances, to produce a sudden depression or arrest of the heart's action. In many, perhaps the majority, of the cases of death from chloroform, the fatal event has been traced to this cause. In valvular disease of the heart, I believe that it may be more safely given. In persons who are epileptic, and in those who suffer from congestion of the brain, it requires to be cautiously administered, as in the early stages of anæsthesia much cerebral excitement is apt to be evinced. In hysterical subjects, chloroform is said to induce a tendency to laryngeal spasm. The most dangerous condition in which to administer chloro-

form is that in which, in consequence of renal disease, the blood is loaded with urea; in such cases epileptiform convulsions are readily induced, with lividity of the face, and a tendency to stertor and coma.

Should chloroform, or any anæsthetic, be given in operations rendered necessary by severe injuries, *during the period of the continuance of the shock of the accident*, as in primary amputations? In such circumstances, its use has been objected to on the ground that it would act injuriously by still further lowering the already depressed vital powers; and that the pain of the operation, if performed without it, would prove a good stimulant, and thus serve to rouse the patient. But would this really be so? Is the pain of an operation a stimulant? In order to answer this question, let us observe the condition of a patient immediately after the performance of a severe operation—as an amputation—without his having been anæsthetised; and we shall find that, so far from having been restored or stimulated, he will have been seriously depressed by it. The pulse will be small, feeble, and slow; the surface cold; and the mind, perhaps, scarcely conscious: in fact, though a slight degreee of pain, as a pinch or a prick, may act as a stimulant, very severe suffering is a most powerful depressing agent, capable in itself of destroying life. The pain of an operation performed soon after the occurrence of a severe injury, so far from rousing the patient, appears to me to act most injuriously, by inflicting a second shock upon the system before, perhaps, it has fairly recovered from the depressing effects of the first; and it is by preventing this that chloroform is of such inestimable advantage In these cases, it is not necessary to give chloroform to an extreme degree of anæsthetisation. It is only requisite to give it to a moderate extent, chiefly so as to benumb sensation during the incisions made through the skin. After this, and during the later stages of the operation, the inhalation may be suspended entirely, or nearly so. It is an interesting physiological fact, that the physical effects of shock is produced on the system even though the patient be completely anæsthetised. This is particularly noticeable in cases of castration in which, at the moment when the cord is cut, the pulse will be found to fall several beats or to stop momentarily, even though the patient be quite insensible. Hence, it may be argued that, although anæsthesia saves the patient that amount of shock which arises from pain, it does not relieve him of that which results from the physical impression produced on the system by a severe mutilation.

Secondary Effects of Chloroform may develope themselves in connection with the *head*, the *lungs*, or the *stomach*. The liability to inconvenient secondary effects depends chiefly on two conditions: 1, on the mode of administration of the chloroform, especially on the care taken that there is an adequate supply of air admitted at the time when the vapor is inhaled; and 2, on the state of the patient as to age, habit, temperament, and digestion. Old people, habitual spirit-drinkers, and those of a bilious and sanguine temperament, are apt to suffer most. The condition of the digestion is of great importance. If chloroform be given too soon after a meal, injurious results are sure to follow; hence, it is best administered on an empty stomach.

Head-Complications chiefly follow the administration of chloroform in the aged. In them headaches and stupor not unfrequently supervene, and occasionally paralytic or apoplectic symptoms will develope themselves some days after the anæsthesia. In young and nervous women hysterical symptoms often appear, and continue for some hours or even days; but they need not excite uneasiness.

Secondary effects { State of patient { Age { Old { Stupor, Paralytic
Temperament { Bilious

Heaving chest

The *Lungs* probably always become slightly congested during the administration of chloroform. But, as recovery takes place, and the respiratory process is naturally re-established, the pulmonary vessels unload themselves, and no inconvenience results. The process is greatly facilitated, and the effects of chloroform are readily got rid of, by desiring the patient to breathe several times fully and deeply after consciousness returns. In some cases the lungs do not unload themselves of the accumulated blood; and a process of slow asphyxia or a low form of pneumonia may set in, and prove fatal in a period varying from twenty-four hours to four or six days. This is especially apt to happen in those cases in which it becomes necessary to bandage the chest, or in which deep respiration is attended by pain, as after amputation of the breast. Great care must, therefore, be employed not to adopt too much constriction of the chest-walls after such operations.

Irritability of the Stomach, attended by continual nausea and vomiting, is sometimes a very distressing after-effect of chloroform, and may be productive of most serious and even fatal results. In many instances it is developed by the patient taking the chloroform too soon after a meal, and is then purely gastric. In other instances it appears to be sympathetic with cerebral disturbance of some kind; in other instances, again, it is connected with kidney-disease. But in any case, and from whatever cause arising, it is a very serious symptom, and, if it continue, often turns the scale against the patient by the exhaustion to which it gives rise. It is best treated by ice and opium.

Death from Chloroform may occur in three different ways: viz., by *Coma*, by *Asphyxia*, or by *Syncope*; through the brain, the lungs, or the heart.

When death occurs by *Coma*, the patient is heard suddenly to breathe stertorously; he becomes livid in the face, and is convulsed; the heart beats until the last moment of life, and death appears to result primarily from the circulation of dark blood through the nervous centres. This form of death chiefly occurs in individuals who are epileptics, or whose blood is loaded with urea.

Death by *Asphyxia* may be produced in one of two ways. 1. It may be the fault of the administrator, sufficient air not being admitted with the chloroform-vapor to maintain the respiratory function. This is especially apt to happen when a patient being semi-narcotised, has a piece of lint saturated with chloroform suddenly applied to the mouth and nose, the heat of the operator's hand and of the patient's body rapidly raising a large volume of vapor. 2. Lister describes the production of asphyxia as being due to spasmodic closure of the upper opening of the larynx, the folds of mucous membrane above the apices of the arytænoid cartilages being carried forwards till they are in contact with the base of the epiglottis, which remains erect and unchanged in position. This theory was founded on observations of the larynx during the production of that peculiar laryngeal stertor which usually precedes the stoppage of the respiration. On pulling the tongue forcibly forward, the arytænoid cartilages were seen to be drawn backward, and the opening of the larynx made perfectly free again; and this seemed to be due to reflex action and not to mechanical causes. This is quite possible during anæsthesia, as the reflex functions of deglutition and respiration are not affected by chloroform as administered for a surgical operation. This state of things may often pass unnoticed till the pulse stops, as the heaving of the chest may go on for some time after air has ceased to enter; the only signs of the state of the patient being the

— Circulatn venous blood
Lungs Insufficient air
heart

gradually increasing lividity of the face, and the fact that no air is entering or coming out during respiration, which can be ascertained by feeling with the hand over the mouth. Lister is of opinion that many of the deaths from chloroform, in which the heart has been said to stop first, were cases of this kind.

In death from *Cardiac Syncope*, the patient, after a few inspirations, suddenly becomes pale and faint; the pulse beats in a flickering manner a few times and then ceases, though respiration may continue: the fatal event being evidently due to paralysis of the heart. This is an accident that may occur to individuals who are depressed either by mental emotion or by physical debility before taking the chloroform; and it is not unfrequently connected with a fatty heart. It is best guarded against by giving the patient a little stimulant, as brandy or ammonia, before commencing the inhalation.

Lister's rules for the administration of chloroform are, to watch the respiration in preference to the pulse; to cease administration at once when the peculiar laryngeal stertor is produced; and if this pass on to complete obstruction of respiration to pull the tongue *forcibly* forwards so as to cause retraction of the arytænoid cartilages by reflex action, and not merely to bring the tip just in front of the teeth as is usually done, under the impression that the obstruction is due to the falling back of the tongue.

The **Administration of Ether** is effected by the application over the mouth and nostrils of a hollow sponge saturated with the best washed sulphuric ether. This mode is preferable to the use of any of the complicated inhalers; inasmuch as, by the admixture in the sponge of a sufficient quantity of atmospheric air with the ethereal vapor, all danger of asphyxia is avoided. To prevent the pungent effects of ether on the cutaneous surface, Warren has proposed the anointing of the face with some protective unguent. The first effects of the inhalation are resistance on the part of the patient, and some slight irritation of the air-passages; the pulse is increased in rapidity, rising to a hundred or more; the face becomes flushed, and the movements and speech of the patient excited. This stage of excitement soon passes, and full etherisation is then effected; the pulse falls to sixty or seventy, the countenance becomes pale, insensibility to pain is produced, and the whole muscular system is relaxed. The indications of this state are the dropping of the upper eyelid, and the inability of the patient to sustain his arm when raised. This is the period most favorable to the performance of operations, and especially for the reduction of dislocations and of fractures attended with shortening of the limb. The time required for the induction of the anæsthetic state varies; averaging, perhaps, about five minutes, a longer period than is required in the administration of chloroform, and it is attended with more excitement. The same precautions that have been described as being necessary during the administration of chloroform, must be attended to when ether is given.

The direct and immediate effects of ether appear to be exercised more on the nervous and respiratory systems and less on the heart than of those of chloroform. There are often much delirium, bronchial irritation, and laryngeal spasm during its administration; and the bronchial irritation may develope into a serious and persistent after-effect. But ether does not appear to act, as chloroform undoubtedly sometimes does, as a direct sedative to the heart's action.

Comparison between Ether and Chloroform.—The history of anæsthetics furnishes an additional illustration of the mutability of pro-

fessional opinion. Ether was almost the only anæsthetic used for the first year after the discovery of its use as an anæsthetic. It then rapidly gave way to chloroform; and so completely was this agent substituted for ether in this country and generally throughout Europe, that a confusion arose in the public mind as to the real discovery of Anæsthesia, and Sir James Simpson, who was one of the first to employ chloroform and to whose energy its general adoption was mainly due, was very commonly considered to be the discoverer of Anæsthetics. In some hospitals, however, and more especially in those of Boston, the birthplace of surgical Anæsthesia, the faith in ether has never been shaken, nor its use abandoned for that of any other agent. In this country a change of professional opinion has to some extent set in, and strenuous efforts have been made since the death of the illustrious discoverer of the anæsthetic properties of chloroform to decry that agent, and to reintroduce ether as a general anæsthetic.

That ether and chloroform are equally effective in the production of Anæsthesia, is undoubted. But the advocates of the first allege that it is the safer agent of the two; whilst those of the latter assert that, admitting the greater safety of ether, it is equally certain that it is less convenient and less generally applicable as an Anæsthetic.

This question, then, has to be examined from three aspects:—1. As to the applicability; 2. As to the convenience; and 3. As to the safety of the two Anæsthetics.

1. *As to Applicability.*—There can be no doubt that in the vast majority of cases both are equally applicable. But there are certain cases in which ether and others in which chloroform appears to possess superior advantages. Ether is preferable in those cases in which from severe shock the nervous powers are greatly depressed, and in those in which there is atony of the heart, whether from fatty degeneration or from an enfeebled and dilated state of the ventricles.

Chloroform appears to be more applicable in all those cases in which it is necessary to maintain the anæsthesia for a great length of time—for many hours—as in the compression of an artery in the treatment of aneurism, and in all those cases in which the galvanic cautery is used in the neighborhood of the mouth or air-passages; the vapor of ether under these circumstances being liable to ignite with explosive violence, as I have seen happen.

2. *As to Convenience.*—In this respect, chloroform undoubtedly possesses a vast superiority over ether, and indeed it was its superiority in this respect that led so rapidly to its substitution for that agent. Snow formerly compared the two agents to a lucifer-match and a tinder-box respectively, and also to an express and a slow train, in which we regard convenience rather than safety.

Chloroform is infinitely more convenient than ether in many ways By it the anæsthesia is more rapidly induced, with less struggling and mental excitement. When once induced, it is more easily maintained complete and unbroken. The quantity required to produce anæsthesia is far smaller. This is a most important advantage in midwifery and in military and naval practice, where the larger bulk of the ether that is consumed in inducing anæsthesia would often render its employment very difficult. So also in ordinary country practice, where Surgeons have to work single-handed or with imperfect assistance, the readiness with which anæsthesia is induced by chloroform, and the absence of violent excitement, is a very important consideration in its favor. The penetrating

and long persistent odor of ether, though of minor import, is not without its advantage to many who are delicate or susceptible.

3. *As to safety.*—No anæsthetic is absolutely safe. It is impossible to annihilate, even temporarily, mental consciousness and physical sensibility without some risk. With ordinary care and some degree of experience, this risk is capable of being reduced to very trifling proportions. So small is the risk, that many a Surgeon goes through a lengthened hospital experience without meeting with a fatal case. But, slight as is the danger from the administration of anæsthetics by competent persons, there is still undoubtedly a certain definite peril attendant on their use. That this is somewhat greater when chloroform is used than when ether is employed is probable—how much greater is uncertain. There are no data before the profession from which a comparative estimate of the relative danger of these two agents can be drawn.

That many fatal accidents have occurred from the administration of chloroform during the twenty-five years in which it was almost the exclusive anæsthetic used in this country, is unfortunately too true. How many of these were inevitable—due to causes beyond the control of the administrator and solely referable to the toxic action of the anæsthetic—is uncertain.

That but few fatal accidents have as yet followed the administration of ether is certain. How far this is due to this anæsthetic being actually safer—*i. e.*, less toxic than chloroform—is uncertain, and the comparison it at present scarcely just. For, since the re-introduction of ether into practice, it has chiefly been employed by professed and experienced anæsthetisers, and much greater skill in the management of anæsthetics has been acquired by the profession than could or did exist in the earlier days of the practice.

The following report places some of the facts respecting the comparative value of chloroform and ether in so clear a light that I have thought it well to reproduce it:—

"*Report on the Administration of Chloroform and Ether as Anæsthetics.* By Surgeon-Major J. H. PORTER, Assistant Professor of Military Surgery.

During the year 1875 chloroform and ether were administered at Netley Hospital in 21 and 26 cases respectively.

The following is an analysis of the time taken to place the patient under its influence, the quantity used, and their general effects as taken from a register kept for that purpose:—

CHLOROFORM.

	Minutes.	Seconds.
Shortest time taken to place under influence . .	2	30
Longest time " " " . .	14	30
Average time " " " . .	6	24
Average time under influence	12	48
Smallest quantity used in any one case . . .	1 drachm.	
Largest quantity used " " . . .	8 "	
Average quantity used " " . . .	3 drachms 9 minims.	

Vomiting occurred in two cases during or after administration of the drug.

Excitement occurred in ten cases during or after administration of the drug.

Great prostration in one case after administration.

ETHER.

	Minutes.	Seconds.
Shortest time taken to place under influence	3	30
Longest time " " "	24	0
Average time " " "	8	10
Average time under influence	19	6

Smallest quantity used in one case, 2 ounces 4 drachms.
Largest quantity used in any one case, 9 ounces.
Average quantity used in any case, 5 ounces 1 drachm.

Vomiting occurred in 11 cases during or after the administration of the drug.

Excitement occurred in 7 cases to a marked degree during or after administration of the drug.

The anæsthetics were invariably given on empty stomachs.

Chloroform by means of a handkerchief or towel folded in the form of a cone, and ether by Morgan's inhaler.

Vomiting and excitement during or after administration of ether having occurred more frequently than one had been led to expect from former experience, the anæsthetic was carefully analyzed and was found to be perfectly pure, and of specific gravity 720·2 at 64° Fahr."

In conclusion, I would say that, with reasonable care and in fairly skilled hands, both chloroform and ether are agents that may safely be administered in the vast majority of cases requiring surgical operations: that in most cases they are equally applicable: that in some chloroform, in others ether, is the preferable agent: that in midwifery, military, naval, and single-handed country practice, chloroform, being far less bulky, more portable, and more easy of administration, is preferable to ether; but that, so far as we can at present judge, ether less frequently than chloroform produces a direct toxic influence on the heart, and is consequently so far the safer agent of the two.

Nitrous Oxide Gas was the first anæsthetic used. Its employment was, however, soon discontinued, ether, and subsequently chloroform, taking its place. It was, however, re-introduced a few years ago as an anæsthetic by the American dentists. It is an admirable anæsthetic, capable of producing complete insensibility; rapid in its action; safe in administration, and seldom giving rise to any unpleasant after-effects. It has, however, one drawback which prevents its applicability to prolonged operations. The class of cases to which the nitrous oxide is applicable as an anæsthetic is restricted, owing to the shortness of the duration of the anæsthesia produced by it, and the suddenness and completeness of the return to consciousness, leaving the after-smart of the operation almost as severely felt as the sting of the cut itself could have been. Nitrous oxide is chiefly of use in operations unattended by cutting, as in the forcible flexure of stiffened joints, the avulsion of toe-nails, extraction of teeth, etc.; or in those cutting operations which are completed by a single stroke of the scalpel or bistoury, as the opening of an abscess or the division of a fistula.

Nitrous Oxide and Ether.—As has already been stated, each of these agents possesses certain disadvantages—the anæsthesia produced by nitrous oxide not being sufficiently persistent to admit of the performance of prolonged operations, that of ether being slow of production and often attended by a species of delirious excitement. By the successive administration of the two anæsthetics, these inconveniences are removed, and the advantages of the two secured. The plan adopted by Clover consists in the rapid induction of anæsthesia by the nitrous

oxide, and the maintenance of this insensibility by the use of the vapor of ether. In this way one anæsthetic supplements the other, and the safety of the one is combined with the persistence of the other.

Bichloride of Methylene, originally suggested as an anæsthetic by Dr. Richardson, has lately been extensively used, especially at Guy's Hospital and at the Moorfields Ophthalmic Hospital. Its advantages over chloroform are said to be greater rapidity of action, complete and rapid recovery, and the absence of muscular rigidity during administration, and of unpleasant after-symptoms. Over nitrous oxide it has the advantage, that the anæsthesia con be maintained for any length of time. Though said to be safer than chloroform, its use is not perfectly free from danger, more than one fatal case having already occurred; and if used for operations lasting more than two minutes, it seems quite as liable to cause vomiting. To produce rapid anæsthesia, it is necessary that the vapor be inhaled in as concentrated a state as possible, all unnecessary admission of air being avoided. For this purpose an apparatus has been devised by Mr. Rendle of Guy's Hospital, consisting of a leather cylinder, open at one end and shaped so as to fit closely over the mouth and nose, the other end being dome-shaped and perforated so as to admit sufficient air for respiration. In the interior of this cylinder is a loosely fitting flannel bag, which overlaps the open end and is secured by an elastic band. The administration is performed as follows. One drachm of the bichloride of methylene is sprinkled on the inside of the flannel bag, and the leather cylinder is immediately placed over the face of the patient; at first it must not fit accurately to the nose and mouth, but, as soon as the patient can bear it, it must be pressed firmly down so as to exclude all air, except such as passes through the bag. By these means anæsthesia sufficient for opening an abscess is usually produced under one minute, passing off as rapidly as it was induced. If the administration be prolonged until the drachm of the bichloride is completely exhausted, the anæsthesia usually lasts about five minutes; the patient on recovering being able to walk away with only a slight feeling of giddiness. If necessary, a second drachm may be used to prolong the effect; but the after-symptoms then resemble those of chloroform, though in a somewhat minor degree. The signs of danger during administration are lividity of the face, and cessation of the pulse and respiration. If they occur, it is best, according to Dr. Bader's advice, to place the patient at once in the recumbent position on the *left* side, with the tongue well pulled forward, when the symptoms will gradually pass off. Dr. Richardson has concluded from experiments on animals, that in fatal cases respiration and the heart's action cease at the same time. In hospital practice, where time is of considerable importance, it has been found to be a convenient plan to induce anæsthesia in the first instance by means of bichloride of methylene; and to maintain it afterwards as long as may be necessary by chloroform.

The **Treatment of the Effects arising from an Overdose of Anæsthetics** is conducted on two principles:—1, the establishment of respiration, either natural or artificial, so as to empty the lungs of the vapor contained in the air-cells, and to aid the oxygenation of the blood; and 2, the stimulation of the heart's action, and the maintenance of the circulation.

The first principle of treatment—that of re-establishing respiration—is most serviceable in the asphyxial form; the other—that of stimulating the heart—when the syncopal symptoms are present. But in all cases they may most advantageously be employed in combination.

The treatment to be adopted on the occurrence of dangerous symptoms, or of apparent death from chloroform, is as follows.

1. The administration of the vapor must be at once discontinued.

2. The tongue should be seized with the fingers, or with a hook or forceps, and drawn out of the mouth; and the larynx pushed up so that the glottis may be opened.

3. Fresh air should be admitted to the patient by opening doors and windows, and by preventing bystanders or spectators from crowding round.

4. All constrictions should be removed from the patient's throat and chest, and these parts should be freely exposed.

5. Artificial respiration must *at once* and without delay be set up, whilst these other measures are being carried out, either by the Surgeon applying his mouth to the patient's lips, and thus breathing into the chest; or, what is preferable, by the alternate and steady compression and relaxation of the walls of the patient's chest.

6. Electricity may be applied freely over the heart and diaphragm through to the spine, by means of the electro-magnetic or other convenient apparatus.

7. As accessory means, friction of the extremities may be employed; a little brandy rubbed inside the mouth; and cold water dashed on the face.

The nitrite of amyl would appear, from the experiments of Dabney on animals and from recent observations on man, to be an antidote to chloroform-poisoning, both in its syncopal and asphyxial forms; the inspiration of the vapor of ten to fifteen drops of the nitrite unloading the vessels and restoring the heart's action.

Local Anæsthesia may be induced by freezing a part. This is done in two ways: 1, by the application of a freezing mixture; 2, by the rapid evaporation of very pure ether. The application of a frigorific mixture of ice and snow, as introduced by Dr. J. Arnott, may very conveniently be employed in many cases in which the internal administration of anæsthetics is either inadmissible or inconvenient. It can only be produced with certainty, however, in those cases in which the incisions merely implicate the skin and subcutaneous structures, as in opening abscesses, slitting up sinuses, avulsion of toe-nails, or removing small and superficial tumors. For all such purposes, however, it is extremely valuable.

The mode of using the *frigorific mixture* is as follows. About a tumblerful of rough ice is put into a strong canvas bag, and finely powdered with a mallet. It is then poured out on a sheet of paper, and half its bulk of salt is quickly mixed with it by means of an ivory or wooden paper-knife. The mixture is then put into a muslin or gauze bag, suspended from a wooden ring, and applied to the part for from five to ten minutes. So soon as the skin becomes white, opaque, and hard, anæsthesia is produced, and the incisions may be made without any pain being experienced. The frozen part speedily recovers itself, no inconvenience resulting.

The *rapid evaporation of highly rectified ether* has been very ingeniously and successfully applied by Dr. Richardson in the production of cold sufficient to freeze a part, and thus render it temporarily insensible. A fine spray-jet of ether of a low specific gravity is thrown upon the part to be anæsthetized. The skin rapidly becomes white and hard—is, in fact, frozen. This method of inducing local insensibility to pain is more exact and efficacious than that by the frigorific mixture, and is generally preferred. It is applicable in the same class of cases.

PERFORMANCE OF AN OPERATION.

The *Incisions* for the operation itself should be carefully and properly planned, so as to give sufficient space with as little mutilation as possible; and in some cases they must be arranged with the view of subsequent extension, should the state of things be discovered to require it. They should be made freely, without tailing; the point of the knife being entered and withdrawn perpendicularly, and made to cut with a rapid sawing motion, due attention being at the same time paid to the resistance of the tissues, so that the Surgeon may not, by using too much force, plunge or jerk his scalpel or bistoury into the part. The scalpel should be set on a smooth ebony handle, which is less slippery than an ivory one when wetted with blood, and admits of greater delicacy of touch; it should be light in the blade, nearly straight-backed, and slightly bellied on the cutting edge. When very free and extensive incisions are required, as in the removal of large tumors, &c., Liston's spring-backed bistoury, of proper size and shape, is a most convenient instrument. Whilst the incisions are being made, care must be taken that too much blood is not lost. This may be prevented most conveniently by the use of the tourniquet, or by an assistant compressing the main artery of the limb. Many operations may be rendered comparatively bloodless by raising the part or limb before the artery is compressed or a tourniquet is applied, so as to empty the vessels of their contents. If the seat of the operation be such as not to admit of this, the assistant must compress the bleeding vessels, as they are divided during the operation; and as soon as it is concluded he must remove his fingers from them, one by one, to admit of their being ligatured, or twisted.

Bloodless Methods.—Various devices have been employed for many years past to diminish the loss of blood. The oldest of these is bandaging the limb firmly to the level at which the tourniquet is applied, before tightening the screw. This was found not to be very efficient, especially when a pad was used over the main artery beneath the band of the tourniquet. Lister has shown that the limb may be rendered almost, if not perfectly bloodless, by simply elevating it as high as possible for about one minute while it is firmly rubbed in the direction of the circulation, and then rapidly applying a tourniquet without a pad. A piece of card should be inserted beneath the screw of the tourniquet to save the skin from being pinched. The most perfect method, however, that has yet been invented, is that of Esmarch, of Kiel, which is thus carried out. An elastic bandage is applied spirally from the lower extremity of the limb upwards to the point at which the tourniquet is to be put on. The tourniquet consists of a stout piece of India-rubber tubing about $\frac{3}{4}$

Fig. 3.—Esmarch's Method.

in. in diameter and 2 ft. in length, having a hook fixed to one end and an eye to the other. This is stretched and wound firmly round the limb

two or three times. It often happens that the hook does not meet the eye exactly as it is wanted to, so that either an extra turn of the tube must be put round the limb, or the former turns unduly relaxed. This may be obviated by replacing the hook and eye by two pieces of stout tape bound on to the end of the India-rubber tube. The tube can then be applied with exactly the amount of force required, and secured by tying the two pieces of tape together. On removing the elastic bandage from below the tourniquet, the limb will be found to be absolutely bloodless, even the bones very frequently yielding no blood on being cut. With the exception of the elasticity of the skin and the retraction of the muscles, the operation exactly resembles one on a dead body. In this state, all vessels of any size can be seen and tied before the tourniquet is removed. On removing the tourniquet, when the blood returns to the wounded part, very free oozing will set in, which often takes some time to arrest by means of cold and exposure to the air. Thus it may happen that the patient loses as much blood as if Esmarch's method had not been employed. Various objections have been raised to Esmarch's bloodless method. It has been stated that it causes sloughing of the flaps and increases the tendency to secondary hæmorrhage after large amputations, by unnaturally augmenting the proportion of blood in the body, and so giving rise to increased arterial tension. Neither of these statements is supported by experience. A more rational objection against it is that when the limb is infiltrated with the products of inflammation, or when perhaps clots exist in the veins, these may be driven on into the circulation by the application of the elastic bandage. Although no case of such an accident has been recorded, it would be safer when such conditions exist to empty the limb of blood by the simpler plan of elevation and gentle rubbing as before described. The same plan is also better employed in cases of cancer or sarcoma, in which the danger of dislodging particles and driving them into the circulation would be very considerable. It must be remembered in applying the India-rubber band that enormous pressure is easily obtained by a few turns one over the other, so much so, that in situations in which the chief nerves lie very close to the bones, as in the arms, symptoms of paralysis lasting some weeks are recorded by Langenbeck as having resulted from its use. The advantages of the bloodless method in operations on diseased bones and joints and in the removal of tumors are even greater than in amputations. Whatever form of tourniquet is employed, it is to be taken off as soon as all the vessels which can be seen have been tied; the assistant, however, if oozing continue after all jetting vessels have been tied, may arrest it by exposure to the air, or by pouring a stream of cold water upon the wound. In some cases the pressure of a pad and bandage, and in others that of a sand-bag, will

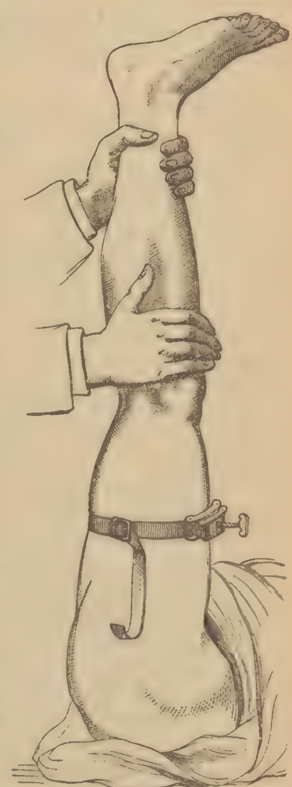


Fig. 4.—Lister's Method.

arrest this bleeding; but in the majority of instances the position and coaptation of the flaps will suffice.

The *Sutures*, if any are needed, should be introduced at the time of the operation, whilst the patient is still under chloroform. If the wound be dressed at once they are tied in the usual way, and the edges thus brought neatly together. If the dressing of the wound be deferred for a few hours, they should be left to hang loose, and not be drawn tight until the wound is dressed. In this way the patient is saved the pain, which is always much complained of, of introducing the sutures at the time of the dressing. They are generally best made of dentist's twist, of moderate thickness, so as not to cut out readily. Silver or unoxydisable iron wire forms an excellent material for sutures in the plastic operations, and in many other cases in which the silk thread is apt to irritate. In some cases, where much tension is exercised, or great accuracy required, hare-lip pins are preferable to ordinary sutures.

Dressing of the Wound.—There is a local as well as a constitutional hygiene. For the proper healing of a wound it is not enough that the general sanitary conditions of the patient be scrupulously attended to. There is a hygiene of the wound as well as of the body that requires scrupulous care. If this be neglected, not only will the healing of the wound be retarded, but the health of the body and the life of the patient will be endangered by contamination from a foul sore or a fetid abscess half filled with putrescent pus and swarming with filth-begotten organisms.

This local or wound-hygiene consists in the prevention of the retention and consequent decomposition of discharge, whether of blood, serum, or pus, by the use of drainage, frequent ablutions, or injections with antiseptic washes, and protection from the air. The dressing of an operation-wound presents nothing peculiar, or that in any way differs from what is adopted in ordinary incised wounds. As a general rule, the wound should be dressed before the patient leaves the table; should there be any reasons for departing from this, the plan that was recommended by Liston, and which was invariably adopted in former years at University College Hospital, is a very excellent one, viz., to leave the wound open with a piece of wet lint interposed between its lips, for two or three hours, until its surfaces have become glazed; the lint is then carefully removed, any small coagula are gently taken away, and the sides of the incision brought into apposition, the sutures being drawn tight and tied. Long strips of plaster of moderate width should now be applied; these may be either of the isinglass or the common adhesive kind, each having advantages that recommend it in particular cases, with corresponding disadvantages that exclude it in others. The isinglass plaster is clean, unirritating, and, being transparent, allows a good view of subjacent parts; but it has the disadvantage of loosening and stripping off when moistened by the discharges or dressings, which often renders it a very inefficient support. The common adhesive plaster is more irritating and dirty, but it is much stronger, and holds more tightly, not loosening so readily when moistened. Should the Surgeon prefer "antiseptic" dressings, he must employ them in accordance with the rules laid down in the Chapter on the Treatment of Wounds. But in any case he must not omit, especially if the operation wound be deep and extensive, to use a "drainage-tube," in order to prevent the retention in it of the serous fluid that oozes from the cut surfaces, and the retention of which in the wound is in many ways most injurious. In some cases, in which the wound is in such a situation as to admit of it, and more particularly

if it be a deep though clean cut—as after the extirpation of a tumor—great advantage will be found, after the sutures have been introduced and the plasters applied, in padding the part externally with a firm compress of dry lint, and then applying a roller tightly but evenly over all, so as to compress the sides against the bottom of the wound and the edges firmly one against the other. In this way will not only all oozing be prevented, but direct coalescence and union of the opposed surfaces may be secured. This dry compress may be left undisturbed for forty-eight hours, when it should be removed and another applied, or, if it appear more desirable, the part covered with water-dressing.

The *position* of the part should be carefully attended to, so that the edges and surfaces of the incision be brought into proper contact; more may be done in this way, without pain or uneasiness to the patient, than by any amount of traction and pressure that can be exercised. The part should be so arranged that one end of the incision may be the more dependent, so as to facilitate the escape of discharges. One end of each ligature should be cut off short, the other being left of a moderate length to hang out of the lowest part of the wound, provided that the thread do not lie along its whole line. A narrow strip of water-dressing should then be applied along the edge of the incision. The first dressings need not be changed until about the third day after the operation, unless they become loose or have been too tightly applied, when they may be snipped across. If the sutures do not interfere with the escape of the discharges, and do not produce undue irritation or excessive traction, they may be left in for a few days longer. In amputations, especially in cachectic subjects, they may frequently be left undisturbed for six or eight days, with much advantage.

If union do not take place by adhesive inflammation, and suppuration have commenced, with much tension and heat about the part, the substitution of a poultice for the water-dressing will be advantageous. When suppuration has fairly set in, the applications should be changed at least twice or thrice in the twenty-four hours, and the wound may with advantage be washed out twice a day with injections of carbolized water. The neglect of this precaution often gives rise to much irritation, and retards the healing process by the accumulation of discharges in and around the wound. Care should also be taken that there is a free escape for the pus, which may sometimes be pent up by the too early cohesion of the edges, without a corresponding agglutination of the deeper surfaces of the wound. As granulations spring up, it may become necessary to substitute astringent dressings for the emollient ones; and the parts must be well supported by bandages, especially in amputations, and in all cases where there is a tendency to bagging of matter.

The **Constitutional After-treatment** of operations demands as much attention on the part of the surgeon as the management of the wound itself. Immediately after the operation, and before the effects of the anæsthetics have passed off, the patient should be comfortably arranged in bed, with the clothes supported by a cradle, or other contrivance away from the part implicated, an opiate should then be administered, or a little wine and water if there be faintness, and the patient kept as quiet as possible.

With regard to the *Diet after the operation*, this must depend entirely on the patient's constitutional powers, his previous habits, his age, and upon the severity of the operation. But, as a general rule, it may be stated that, as an operation is a shock to the system, the constitutional powers require to be maintained after its performance. This is more

particularly the case, if the mutilation be severe, or the subsequent suppuration abundant. If the patient's strength be good, not having been broken by previous disease or suffering, and if the operation be a slight one, as the amputation of a finger, or the removal of a small tumor, he may have half his usual diet allowed for a few days, but with little, if any, stimulants. If the operation have been more severe, but not capital, no solids should be allowed, but broths and nourishing liquids alone given for the first few days. If the operation have been a capital one, the patient's health and strength being otherwise good, he may be restricted to farinaceous slops and beef-tea until suppuration has come on; indeed, up to this time, the febrile reaction will usually prevent the patient from taking solid. Some light pudding may then be added; and the diet may, as the case progresses, be gradually improved by the successive addition of fish and the lighter kinds of meat, with a moderate quantity of stimulants, as required, until it reach the normal standard. It not unfrequently happens, however, that a totally different course must be pursued. It is not my intention to enter upon the great question of the use and abuse of alcohol as an article of diet. But as a medicinal agent in severe surgical cases there can be no doubt of the great utility, indeed the indispensable necessity, of alcohol in some shape. If the patient have been much reduced by the long-continued suppuration, or other depressing causes before the operation; if he be old and weakly in constitution, or have been in the habit of taking a very considerable quantity of stimulants, it will be absolutely necessary to adopt a tonic and stimulating mode of treatment. Indeed, in hospital practice especially, this is by far the most successful mode of treating patients after severe operations; without it, many would have sunk, whom I have seen saved by the free administration of large quantities of brandy, wine, porter, eggs, and beef-tea from the very time of the operation; that stimulant being given to which the patient is accustomed in a state of health. This plan of treatment is also one of the best preventives of those low and diffuse forms of inflammation that are so commonly fatal in these cases; and when they come on, I know no better remedy than the brandy-and-egg mixture, freely administered. In all this, however, the Surgeon must be guided by the patient's pulse, his previous habits, and the strength of his constitution; and nothing requires greater judgment than the administration of stimulants, according to these particulars. The great importance of attending scrupulously to the general cleanliness of the patient, and to the ventilation of the ward or room in which he is lying, as the best means of preventing the occurrence of the lower forms of inflammatory mischief, need scarcely be insisted on, as these hygienic precautions are universally recognized as being of the first importance under such circumstances.

The *remote effect* of the major operations is a subject that requires investigation. Do people who have undergone any of the greater operations, and who have recovered from the immediate effects, as a rule, live as long as those who have not sustained a mutilation? I am disposed to think that they do not. When we reflect on the enormous number of persons who suffer amputations, of one of the limbs from injury, under the age of thirty, it is remarkable how seldom one sees an old person in a hospital or elsewhere, who lost a limb in early life. I am, of course, only speaking of amputations for injury. Those who have undergone this operation for strumous or malignant disease, necessarily frequently die early from recurrence of the constitutional vice in other parts of the body. So also with respect to lithotomy. Very many boys are cut for

stone every year and recover, but I scarcely recollect to have ever met with a middle-aged adult who had been operated on in childhood.

The various Special Operations will be considered when treating of the several Injuries and Diseases for which they are required; but, as Amputations do not readily fall under any special head, being required for a vast variety of different conditions, it will be more convenient to consider them here.

CHAPTER II.

AMPUTATIONS AND DISARTICULATIONS.

THE term *Amputation* means the separation or removal of a part of the body. It is most commonly applied to the removal of a limb, but sometimes also to that of other parts, as the breast or penis.

The frequency of amputation of the limbs has much lessened of late years; other and less severe modes of treatment being now successfully followed in many cases of diseased joint, of aneurism, and of compound fracture. Still amputations are among the most frequent operations in surgery, and will continue to be so as long as the human body is liable to severe mutilations, to gangrene of the limbs, and to malignant and other incurable diseases of the bones and joints. It has been somewhat the fashion to decry amputation; and to speak of this operation as an opprobrium to curative surgery. But, though no surgeon can deprecate unnecessary amputations more strongly than I do, yet I cannot admit that the removal of a limb is an operation of less merit than any other proceeding adopted when all other means have failed in curing the diseased part, or in saving the patient's life from danger. And, surely, it is rather a subject of just pride than the reverse, for the Surgeon to be able to save the whole of the body by sacrificing by a simple operation a limb that has been utterly disorganized or spoilt by disease or injury. In the performance of an amputation, also, much dexterity may frequently be displayed; and there is commonly great scope for surgical skill in the constitutional treatment of the patient both before and after the operation.

The amputation of a limb is generally performed through the continuity of a bone; when done at a joint, it is called a *Disarticulation.*

THE PERFORMANCE OF AN AMPUTATION.

In performing an amputation there are several distinct steps which must be considered separately. They consist in—1. The prevention of hæmorrhage during the operation; 2. The mode of forming the flaps or of cutting through the soft parts; 3. Sawing the bone; 4. The arrest of hæmorrhage after the removal of the limb; and 5. The dressing of the stump.

1. PREVENTION OF HÆMORRHAGE.—The loss of blood during the operation is the great primary danger which must be carefully guarded against. As a general rule, it is better to prevent this by the application of a tourniquet than by trusting to the compression of the artery by an assistant's fingers; the tourniquet arrests the flow of blood through the collateral vessels as well as through the main trunk, whilst the finger can

only stop the current of blood that passes through the latter. When the tourniquet is applied, the pad should be carefully placed over the artery, and the band buckled rather tight; but the instrument should not be screwed up until the moment of the operation. It should then be tightened rapidly, so as to lessen the liability to congestion of the lower part of the limb that always occurs when a tourniquet is applied, but which is especially apt to ensue when the instrument is slowly screwed up. The first effect of the tightening of the tourniquet is to compress

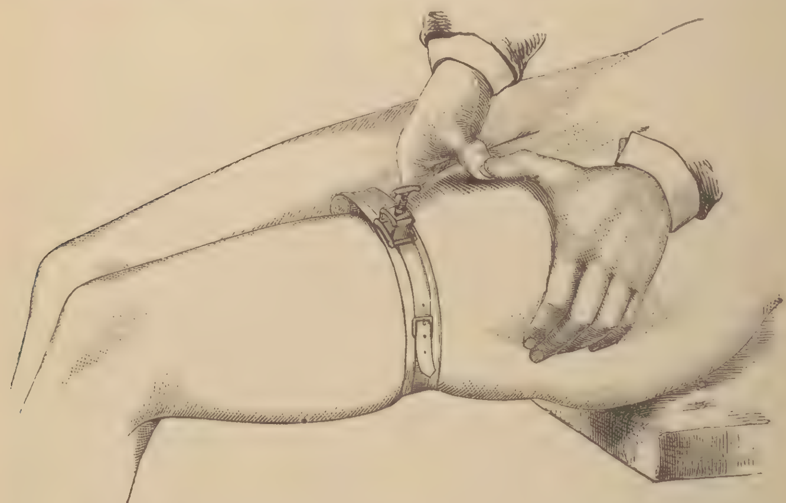


Fig. 5.—Pressure with Thumbs. Application of Tourniquet to Femoral Artery.

the large veins of the limb; the second, to arrest the flow of blood through the arteries: hence the more slowly it is caused to act, the greater will be the venous engorgement of the limb. The blood that flows from the limb during an amputation is almost entirely venous, coming from the lower part of the member. In those cases, as of chronic disease, in which it is of great importance to save blood as much as possible, it is a good precaution either to keep the limb raised for a few minutes before the application of the tourniquet, or to bandage it tightly from below upwards immediately before the tourniquet is applied; thus not only preventing all the venous congestion, but emptying the vessels of their contained blood. When this is done, the tourniquet should be applied without a pad. In this way the amputation may be rendered almost bloodless, or Esmarch's method, described at page 54, may be adopted. So soon as the main arteries have been tied after the removal of the limb, the tourniquet may be unscrewed and taken off; the assistant, however, keeping his finger on the artery above the stump, lest any vessels have been left untied, or a ligature slip. If the band be left only half loosened, it will often happen that venous hæmorrhage continues abundantly from the stump, in consequence of the pressure of the instrument being still sufficient to prevent the return of the blood through the veins. This will at once cease on taking the tourniquet completely off, and elevating the cut surfaces.

2. Mode of Cutting through the soft parts.—In amputations and disarticulations, the Surgeon has the choice of four *Operative Pro-*

cedures:—(1) The circular method; (2) the oval method; (3) flaps of various sizes and shapes; and (4) a combination of skin flaps with a circular cut through the muscles. It is not my intention to enter into a discussion as to the relative merits of the *circular* and *flap* methods, for which I would refer to the writings of Liston and Velpeau. I believe that by either the circular or the flap method an equally good stump may ultimately be formed; but that much will depend upon the special dexterity which the Surgeon may have acquired by the habitual performance of one or other of these operations. Educated in the doctrines of Liston, who invariably amputated by the flap method, and who certainly did this with wonderful rapidity and precision, I have been in the habit of performing this operation in preference to the circular, over which it certainly possesses the special advantages of greater celerity in performance, more perfect coaptation and smoothness of the opposite sides of the wound, and a greater tendency to union of the stump by the first intention. But, though giving the preference as a general rule to the flap amputation, I would not by any means wish it to be understood that I urge its adoption in all cases, or would wish to exclude entirely other methods of operating. In injuries, especially, no one method can always be adopted, the Surgeon often being obliged to fashion his stump as best he may in accordance with the conditions to which the limb has been reduced by the injury inflicted on it. Many other points have to be considered, such as the best covering for the bones, the best pad for an artificial limb, and the best drainage for the stump during the healing process.

But it is interesting to observe how the method of amputating has been materially modified in consequence of the general employment of

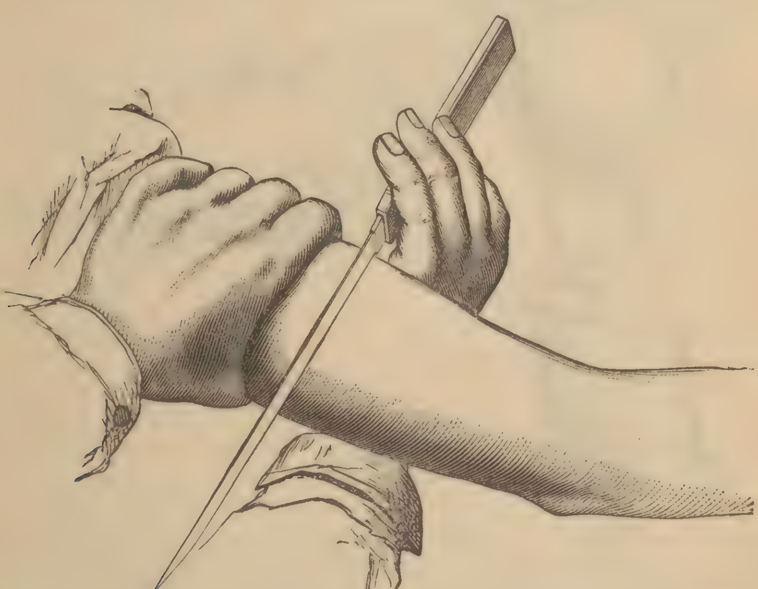


Fig. 6.—Amputation of the Arm by the Circular Method. Commencement of first incision.

Anæsthetics. In the pre-anæsthetic days, the only means of saving pain was by rapidity of operating. Hence rapidity became an important ele-

ment in the performance of so severe an operation as an amputation; and this was secured by the flap method, the process of transfixion and of rapid cutting outwards being much less painful than that of a slow cutting inwards. But as Anæsthetics are now trusted to for securing immunity from suffering, rapidity is of less importance than it was formerly. Hence many methods of amputating that were discarded a quarter of a century ago have regained their ascendancy, and Surgeons now deliberately carve out flaps by cutting from without inwards, regardless of the greater length of time required, provided the result is more satisfactory.

Amputation by the Circular Method.—In this amputation, the skin and fat are first divided by a single sweep of the knife and dissected up for a distance equal to half the diameter of the limb; the muscles are then divided by another circular sweep of the knife and retracted for a distance varying from one to two inches, according to the thickness of the limb; and the bone is sawn as high up as possible. In the thigh and leg it was recommended by Hey to cut the posterior muscles longer than the anterior, to allow for their greater contraction. The edges of the skin are brought together in the transverse diameter of the limb, and a stump is formed with abundant covering for the bones, but necessarily with some puckering and projection at each angle.

Fig. 7.—Amputation of the Arm by the Circular Method. Sawing the Bone.

During the late Franco-Prussian war, the circular was the method almost universally adopted by the German surgeons; the advantages they claim for it being that much less care is required in the after-treatment than in the flap method, as the covering to the bones, containing

no muscle, is less liable to be displaced, and the patients will consequently bear transportation from the field hospitals at an earlier period, a matter of no small importance in military surgery; there is also said to be less liability to sloughing than when the operation is performed by long skin flaps.

In some cases of malignant disease, also, when it is desirable not to approach too nearly to the diseased portion of the limb, the circular may be found a safer operation than the flap method, so far as the ultimate condition of the patient is concerned, in lessening the liability to recurrence.

The *oval* method is especially applicable to certain amputations and disarticulations of the bones of the hand and foot. It presents no advantage in the larger amputations.

Flap Amputation.—In performing flap amputations by transfixion, the Surgeon should stand so that he may support and grasp the limb to be removed; the left hand being placed on the outer side in amputations of the left limbs, on the inner side in those of the right. When the flaps are cut from without inwards and raised by a process of dissection, the Surgeon will find it more convenient to stand on the right-hand side of the limb, so that he may take the flaps himself while he leaves the limb to the care of an assistant. He will commence to cut the flap at the side farthest from him.

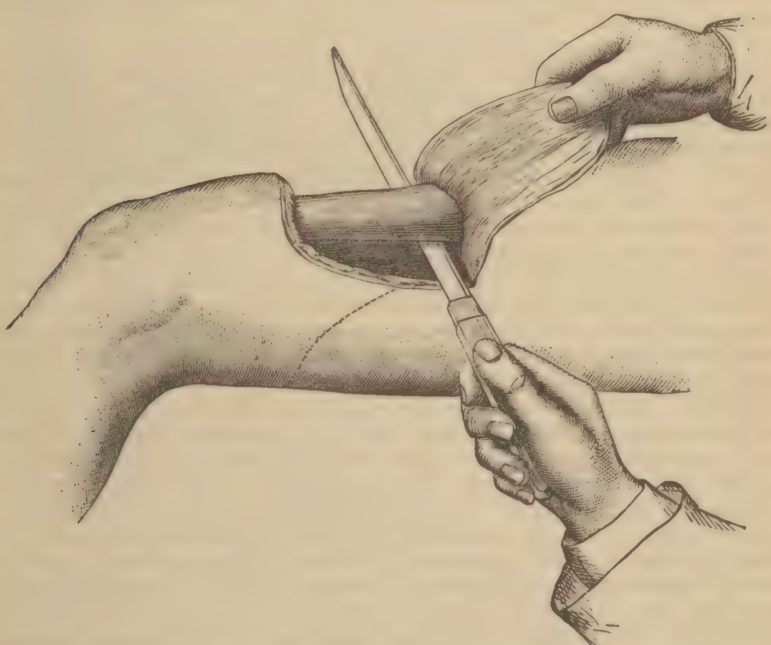


Fig. 8.—Amputation of the Thigh. Antero-posterior Flap Operation. Flaps cut by transfixion.

The *Amputating Instruments* must be in proper order, and of good construction. For the smaller amputations the Surgeon will require straight spring-backed bistouries, narrow or broad in the blade, according to the size of the part to be removed. Scalpels, also, not too broad in the blade, are useful in cases in which the bistoury, from its length,

might be inconvenient. Cutting-pliers, with long and strong handles and short blades, either straight or curved, as may be most convenient, are especially required in amputations about the hands and feet. The knives for the larger amputations should have smooth ebony handles, and be well balanced. The back of the blade should run straight to the point and be well rounded. The edge should taper off towards the point, with a good convexity. The breadth of the blade should vary from $\frac{3}{5}$ to $\frac{2}{3}$ of an inch, and its length should be proportioned to the thickness of the limb to be removed. As a general rule, in order to make a good sweeping cut, so as to form a well rounded and smooth flap, the blade should be in length equal to about double the thickness of the limb. The saw should be strong in the blade and back, so as not to bend in cutting. The blade must be of good breadth, and, in order not to hang as it works its way through the bone, must be somewhat thicker at the cutting edge than elsewhere. The teeth should not be too fine, and must be set crossways. The artery-forceps may either be of the ordinary "bulldog" make, or may be broad towards the point, so as to allow the knot more readily to be slipped over the vessels to be tied.

Amputations by flaps fashioned from the soft parts so as to cover the bone and form a well-cushioned stump may be performed in several different ways: by double flaps, by one long rounded flap, or by one long and one short square flap.

The *Double Flap Amputation* is that which is usually practised, and that we shall first consider.

The two flaps may be made either by cutting from without inwards, or by transfixion—cutting from within outwards. I generally prefer transfixion in fleshy parts, as the thigh or arm; but cutting from without inwards will be found to afford the best result, and is indeed the only mode of forming the flap, in some situations in which the bones are naturally thinly covered, as on the outer side of the fore-arm, the anterior part of the leg, or just above the ankle-joint, or where the soft parts have been wasted by chronic disease. The flaps should be made by a steady sweeping cut, so that the soft parts may be evenly and smoothly divided. Their length must of course be proportioned to the thickness of the limb; and on this point no positive direction can be given, except that care be taken that they be not cut too long nor too short. If they be cut too long, too much muscle will be left on the stump, and the flap itself is usually badly fashioned and pointed. Should the Surgeon feel that he has made this mistake, the wiser plan will be at once to round off the ends of the flaps. Should they have been cut too short, the soft parts must be forcibly retracted, and the bone cleared by circular sweeps of the knife, and sawn as high up as possible.

The flap farthest from the vessels, as that on the outer side of the thigh or arm, should be cut first. In making the inner flap, great care must be taken to wind the point of the knife well round the bone, so as not to transfix and split down the vessels, but to cut them as long as possible. As a general rule, the less loose muscle that is left on a stump, the better: hence, where there is an equal thickness of soft parts round the bone, as in the arm and thigh, the flaps should be cut short, well retracted, and the bone cleared by circular sweeps of the knife as high as necessary. The bone thus lies at the bottom of a conical hollow beyond the angle of junction between the flaps, and there is less chance of a conical stump being left.

In cutting a flap from without inwards, it is of the greatest importance to remember that the edge of the knife must never be turned towards

the under surface of the flap, but always towards the parts to be removed. After marking out the flap with the point of the knife, the Surgeon takes the edge of the skin lightly between the finger and thumb of his left hand, and raises it from the parts beneath. The portion of the flap which is thus raised is therefore at right angles to its former position on the limb, and the knife must also be kept in a similar direction, or its edge will be turned towards the base of the flap, and by scoring its under surface will greatly increase the dangers of sloughing. There should be no hurry about raising a flap by dissection, as under the influence of anæsthetics the lengthening of the operation by two or three minutes is a matter of but little importance. It is better to spend one or two minutes more over the operation, than to have to re-amputate on account of sloughing of the flaps.

In 1839, Liston proposed a combination of the double flap and circular operations, which greatly improved the shape of the stump of the circular method, and somewhat increased the ease of the operation. Two semilunar incisions, with their convexities downwards, are made through the skin from side to side of the limb: the flaps are thus dissected up so as to expose the muscles somewhat higher than the angles of union of the

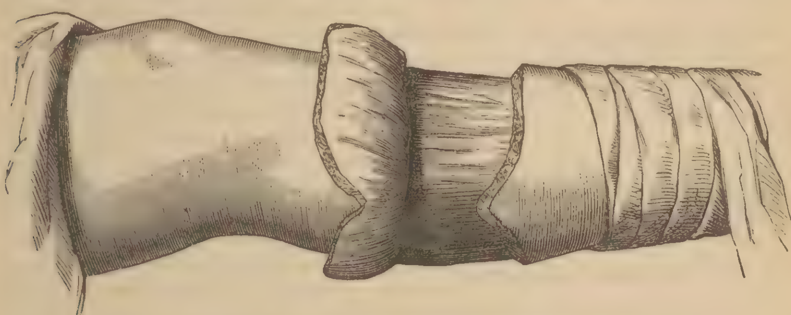


Fig. 9.—Modified Circular Amputation in the upper third of the Leg.

flaps: and the operation is completed as in the ordinary circular method. This method of operating is especially indicated in muscular parts, such as the arm, thigh, or leg. This is more particularly the case where the amputation is primary, as then the muscles often retract to so great an extent that it is difficult to judge of the proper length at which to cut them. The advantage of this procedure over the ordinary flap or the circular operation is very great in certain circumstances. In both cases, but more especially in flap-operations on stout muscular subjects, a large pad of muscle is apt to be left in the stump. This, which at first sight might appear an advantage, as an additional covering to the bones, is a decided disadvantage, inasmuch as it often projects through the retraction of the skin covering it, and is apt to slough and interfere with the proper union of the flaps. This pad is also disadvantageous after cicatrisation is completed, as at first it forms a soft, flabby, and bulbous end to the stump, instead of a firm hard cicatrix; and eventually it must waste and undergo fibro-cellular transformation, before the stump is finally consolidated. Hence, a stump that at first appears to be covered by a good cushion of soft pads, will, if these be chiefly muscular, gradually shrink and waste, and may at last become conical. If the limb have been the seat of much and long-continued suppurative action, the muscles do not retract when cut, but hang soft and flaccid, as in a dead body.

The flaps, therefore, need not be made so long as in primary amputation for injury. And here, also, too much muscle is disadvantageous, getting between the skin-flaps, and occasioning trouble and delay in the healing of the stump. If, however, the flaps be themselves much infiltrated by inflammatory products, they must be cut so as to look somewhat long at the time of the operation, or else, as cicatrisation advances and the inflammatory products become absorbed, they will be found to be too short, and a conical stump will result.

Amputation by the Rectangular Flap.—The late Mr. Teale, of Leeds, for some years practised amputation by a long and short rectangular flap, with the view of procuring a more useful stump, and in the hope of somewhat diminishing the mortality of the operation. In performing amputation by this method, the long flap is cut from that side of the limb where the parts are generally devoid of large blood-vessels and nerves; whilst the short flap is made to include those structures, which are cut across transversely, as shown in the annexed figure from Teale. The long flap is perfectly square; and the rule for its formation given by Teale is, that its length and breadth should each be equal to the half of the circumference of the limb at the place where the bones are to be sawn. If the circumference be 9 inches, the length and the breadth of the flap should be each $4\frac{1}{2}$ inches. Both flaps should include all the soft parts of the limb. The short flap, which is always cut so as to contain the chief vessels and nerves, is one-fourth of the length of the long one. The bones are sawn exactly at the angle of union of the flaps, without any previous retraction of the soft parts. The vessels are then tied, and the long flap is folded over the end of the bone, and attached by sutures, as in the accompanying figure, to the short flap. Teale directs that the stump should be laid on a pillow lightly covered with gauze or linen, and protected from pressure by a cradle; but in the early treatment he says that no dressings are required.

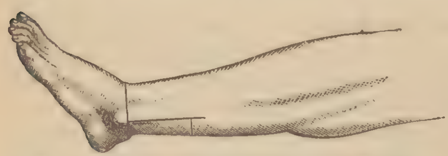


Fig. 10.—Lines of Incision in Teale's Amputation.

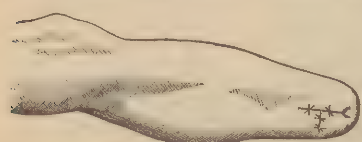


Fig. 11.—Teale's Amputation: Stump.

The *Results* of amputation by this method were very satisfactory in Teale's hands; but more abundant evidence is required in order to show whether the mortality of amputations generally is dependent on the particular method adopted, rather than on constitutional causes and external influences that operate equally in all cases.

The rectangular method undoubtedly possesses one very great advantage over the circular or ordinary flap, in giving a soft and loose covering to the ends of the bones, admitting of direct bearing upon them; especially advantageous after the amputation of the thigh or leg, when direct pressure can scarcely be dispensed with, and when a solid firm stump admitting it is of very essential service to the patient. Teale advises, however, that the whole pressure be not borne by the stump, but that it be reduced to one-half, the remainder being distributed in the usual way on the upper part of the limb and trunk: thus not only relieving the stump, but securing greater steadiness of gait and firmness of step. In the upper extremity, however, no direct pressure is made

upon the end of the stump in the adaptation of artificial limbs; hence, in amputations of the fore-arm or arm, a thickly covered stump is not so much the object of the Surgeon as in the leg and thigh. In the former instances, therefore, the rectangular appears to possess no advantage over the double flap method, so far as the after utility of the stump is concerned. Teale also claims as advantages of his method that there is provided a free dependent opening for the exit of discharges, and that when healed the cicatrix is far removed from the ends of the bones, being drawn up above and behind them.

But, whilst fully admitting the advantage possessed by the rectangular method in the formation of a well-cushioned stump, especially in the lower extremity, we must not close our eyes to certain disadvantages which appear to me to be inseparable from it. The disadvantage consists in the necessity of sawing the bones at a higher point when one long flap only is made, than when two shorter ones of more equal length are fashioned. Thus, for instance, in an amputation of the thigh for injury or disease of the knee-joint, the long rectangular flap in an adult would require to be about eight inches in length, and the femur must consequently be sawn at least as far as this above the patella; whereas, in the ordinary double-flap amputation, two shorter flaps, each about four inches in length, will be found sufficient to cover in the bone, which may consequently be sawn at a proportionately lower point Thus the rectangular method contravenes one of the best-established principles in amputation, viz., not to remove the limb at a higher point than is absolutely necessary, the danger to life increasing with every inch that is removed; nor can it be considered to be advantageous in those cases in which length of stump is essential to the after-comfort and utility of the patient.

Moreover in many injuries of the limbs requiring amputation, the soft parts are often torn in such a way that a good covering may be got for the stump below the knee or elbow by short double flaps, or even by the circular method, when there would be no possibility of fashioning a long flap from uninjured soft parts below those joints; and the increased risk of high amputation would have to be encountered.

In amputation for malignant disease, also, the long flap, which has to be cut in close proximity to the morbid growth, would run a far greater risk of infiltration than would two shorter ones taken higher up in the limb; the bone in both cases being sawn at the same level.

Should union by the first intention fail, and suppuration set in, in the rectangular amputation, the thick fleshy mass which enters into the conformation of the long flap becomes a source of great inconvenience, bulging out from under the skin, and requiring considerable management in the after-treatment.

Spence has devised a modification of Teale's method, by which he obtained all its advantages by a much simpler operation. He does not make a posterior flap, but compensates for it by retracting the soft parts from the bones to an extent equal to its length. The anterior flap is made a little longer than the diameter of the limb; and its angles being rounded, it is allowed simply to hang over the end of the stump, without being folded upon itself as in Teale's operation. The posterior parts are divided from without inwards by a single sweep of the knife. Equally good results may be obtained, as suggested by Liston, with still shorter flaps, by the following operation. An anterior rounded flap, equal in length to two-thirds of the diameter of the limb, is raised by cutting from without inwards, taking with it as much muscle as may be required

to form a good cushion over the bones; a posterior skin-flap is then made rather more than half the length of the anterior, also rounded in shape. The posterior muscles are cut as short as possible, so as to set the flap free from the effects of their contraction. The soft parts are then retracted for about two inches and the bones sawn. By these means all the advantages claimed by Teale for his method, viz., a good covering, a dependent opening for discharges, and a cicatrix free from the pressure of the end of the bone, are obtained with the smallest possible sacrifice in the length of the limb. As by all these methods the cicatrix is some way posterior to the end of the bone, the patient is capable of bearing a certain portion of his weight directly on the end of the stump, which gives greatly increased steadiness and power in the use of the artificial limb.

Amputation by one Long Flap.—In some amputations, as at the shoulder and hip-joints, owing to the anatomical configuration of the parts, only one long flap can be made. And in others, as in the removal of the fingers through a phalangeal articulation, or of the metatarsal bone of the great toe, it is found more convenient to make but one long flap, cutting through the soft parts transversely on the opposite side of the limb. This method has been extended by some Surgeons to all amputations, but it appears to me to possess no advantage over the double flap, and to be attended by the same inconvenience as that which accompanies Teale's method.

3. Sawing the Bone.—So soon as the incisions have been made through the soft parts, the bones must be cleared for the application of the saw. This is best done, when there is only a single bone, by a firm circular sweep of the knife from heel to point round the under segment of the bone, and then another round the upper surface in the opposite direction. If there be two bones, care must be taken in clearing them not to direct the edge of the knife upwards into the interosseous space higher than the line to which the saw is to be applied, lest an artery be cut where it would, on account of its retraction, be difficult to secure it.

The bone having been properly cleared, the flap must be firmly retracted by an assistant, in order to allow the saw to be applied opposite the highest point of the incision through the soft parts. For the purpose of retraction, the assistant's hands are quite sufficient, though some surgeons still use "*retractors*," made of split pieces of linen cloth or of wash-leather. But, although "retractors" may not be required for the purpose of drawing back the soft parts, they are of great use in protecting the muscles from the teeth of the saw and from the bone-dust produced; for the laceration of the deep muscles by the saw, and the imbedding of particles of bone-dust in their substance, interfere seriously with union. In order to saw the bone quickly and steadily, there are several points deserving attention. The first cut should be made so as to form a deep groove to receive the teeth: to do this, the heel of the saw is steadied against the left thumb, which is pressed on the bone; and the instrument is drawn fairly and sharply along the whole line of its teeth from heel to point. The groove thus formed receives the edge of the saw; and the bone may then be quickly cut through by long, light, and sweeping movements of the instrument from point to heel, the position being gradually changed from the horizontal to the vertical as progress is made. The Surgeon must, with his left hand, support carefully the part to be removed; neither depressing it, so as to snap the bone as it is weakening by sawing; nor raising it so as to run the risk of locking the saw. When the Surgeon takes charge of the flaps him-

self, the care of the limb must be left to an assistant. When they are two bones in the limb of equal strength, as in the fore-arm, they should be cut through at the same time; but in the leg, the fibula, being the weakest, should always be first divided. Should the division be made irregularly, and splinters of bone project, these must be snipped off with cutting-pliers.

4. Arrest of Hæmorrhage.—After the limb has been removed, the first thing to be done is to restrain arterial hæmorrhage. This may be effected by one of three methods:—ligature, acupressure, or torsion. If ligatures be used, the main and larger arteries must first be tried. For this purpose, fine compressed *whipcord* is the best material. The ends of these ligatures, knotted together, must be left long, so that they may be distinguished. Usually from two to four or six smaller vessels require to be tied, and they should be secured with ordinary ligature-thread; but sometimes, either from the existence of malignant disease, or of extensive suppurative action in the limb, the stump is excessively vascular, and a very large number of ligatures may be required. I have, in these circumstances, more than once had occasion to apply between twenty and thirty ligatures to vessels in the arm and thigh. As union always takes place by granulation in such cases, it signifies little how many ligatures are put on, the smaller ones separating early. One half of each ligature should be cut off close to the knot, and the single threads thus left must be brought out at the lower angle of the wound, through which any discharge that may form may drain away. *Silver* or *iron wire* may be used for ligaturing the arteries, with the view of preventing the suppuration that results from the irritation of the ordinary silk or thread ligatures, and thus facilitating union by the first intention. I have employed wire in several instances, but have found that it does not cut through the artery as the thread does, and consequently does not detach itself, but requires to be pulled or twisted off—a procedure which may be attended by hæmorrhage. The practice of cutting the ends of ligatures short, whether hempen or metallic, is most objectionable: for, although the stump may heal over them, they eventually become sources of irritation, and set up suppuration or develope neuralgia. During the last few years carbolised catgut ligatures have been extensively used, being cut short and left in the wound. Their use has been found to be attended by no evil consequences, even when the antiseptic mode of dressing is not adopted.

Acupressure, and torsion of the ends of cut arteries, are often employed instead of the ligature by the advocates of these methods. For a detail of the mode of arresting hæmorrhage by these means, and for a comparison of their merits with those of the ligature, I must refer to Chapter XIV.

Free arterial bleeding will sometimes take place from a point in the cut surface in the bone, in consequence of the division of the trunk of the nutritious artery. This hæmorrhage is best arrested by pressing a small wooden plug into the bleeding bone. To this a piece of wire should be attached, so that it may be drawn out when loosened by suppuration at the end of a few days.

The mode of union of the flaps of a stump, the dressing required, and the general management of the part after an amputation, differ in no respect from what takes place in the healing of primary incised wounds, to be hereafter described.

5. Dressing the stump.—An amputation leaves a clean cut wound, which must be treated on those principles that guide the Surgeon in the

management of all incised wounds, and which will be fully described in Chapter IX. They may be summed up briefly thus:—1. Removal of all coagulum, bone-detritus, or other foreign body; 2. Close and accurate coaptation of flaps; 3. Efficient drainage to allow escape of sero-sanguineous fluid; 4. Perfect rest of the part; 5. Scrupulous attention to cleanliness, and to avoidance of decomposition of fluids. Callender's method of treating stumps seems to combine these requisites more perfectly than any other. It consists essentially in the use of a drainage-tube for from twenty-four to thirty-six hours, so as to allow the escape of bloody serum, placing the stump on a well-padded splint, to which it is bandaged, so as to prevent all voluntary movement and disturbance by involuntary twitchings and dressing the cut edges with lint soaked in carbolic acid and oil and cleansing them when necessary with a glass brush dipped in a strong spirituous solution of carbolic acid.

Sutures may be either of well waxed silk or of metallic wire. They should be introduced through the lips of the incision at intervals of an inch: care being taken to leave the most dependent angles of the stump open, and to draw out the ligatures through them. In case of primary amputation for injury, or in any case in which oozing is expected, the sutures should be introduced whilst the patient is under chloroform, and left loose. When this is done, silken sutures must be employed, and wet lint applied between the surfaces and over the outside, the dressing of the wound being deferred for a few hours, until the surfaces are glazed; a slip of lint, wet with carbolized water, being interposed between the flaps, and this removed and the stump dressed in six hours. But in amputations for disease, when patients are in a low and irritable condition, it is better to apply the dressings immediately after the performance of the amputation, before the effects of the chloroform are recovered from. In these cases metallic sutures should be employed; they are less irritating, and may be retained longer. Before dressing the stump, it is desirable that all oozing should have ceased, lest a coagulum form between the flaps, and so interfere with union; with this view, a jug or two of cold water may be poured over the face of the stump. The dressings should then be applied. They should be as light and unirritating as possible. The object that we have in view is the union of the flaps as speedily as possible—not only along their edges, but throughout the deeper portion of the stump. Strips of adhesive plaster, about fifteen inches long, should be applied between the points of suture, and the stump bandaged from the upper part of the limb as far as the line of incision, so as to bring together and steady the deeper parts of the wound, more particularly where the bone intervenes between the flaps. A piece of wet lint, kept constantly moist with cold carbolised water, should then be laid over the line of incision, the stump comfortably supported on pillows, and the weight of the bedclothes taken off by a cradle. After this, it should be disturbed as little as possible for a few days. The carbolised lint, which will become soiled by a reddened sero-sanguinolent discharge, must be changed every few hours. Should the flaps be muscular and heavy, the stump may advantageously be supported on a well-padded wire splint.

Union by the "first intention" can only be expected to take place in certain amputations, and even in them not wholly and entirely. When the bone is very large, as the femur, an angle is apt to be left between the flaps at the apex of the stump, which, by preventing complete coaptation at this point, renders direct union impossible; so also, if a cavity exist in the bone, as the glenoid or cotyloid, in amputation at the shoulder

and hip, there will necessarily be suppuration. Then, again, muscle will not adhere directly to synovial membrane or to cartilage in disarticulations, and in many cases not even to the cut surface of bone. In fact, for all these reasons, independently of any constitutional causes, complete primary union, or that by first "intention," is much more rare than is commonly supposed, and is more frequently talked about than seen, in amputations. However, whatever portion of the stump unites directly and primarily is so much gained, and no effort should be left untried to secure so desirable a result.

When suppuration sets in, warm-water dressings should be substituted for the cold lint, and every possible attention should be paid to cleanliness by a frequent change of the dressings, more especially in warm weather.

When suppuration is subsiding, and cicatrization going on, the bandage may advantageously be brought over the face of the stump. As a general rule, it will be found that a narrow roller will adapt itself better than a broad one. After cicatrization is completed, the patient should be allowed to go about on crutches, but must not wear an artificial limb for several months, until the parts have become firmly consolidated; during the whole of this time the stump should be kept carefully bandaged, and not exposed to injury.

Simultaneous or Rapidly Consecutive Amputation of Two Limbs, requiring removal for severe injury or for gangrene, has occasionally been successfully practised, either by two Surgeons performing the two amputations at the same time; or by the same Surgeon doing first one and then the other, the vessels of the first limb being secured by an assistant whilst the second limb is being removed. The circulation through both lower extremities may be completely arrested by compressing the aorta by means of Liston's tourniquet. By means of this valuable instrument, I have amputated both thighs in close succession without waiting for the ligature of the arteries in that which was first removed. The object in two simultaneous amputations is to lessen the continuance of shock to the system, by throwing, as it were, that of the two operations into one. In doing this, however, the Surgeon must necessarily be guided by the circumstances of the case. If the patient were very greatly depressed, the infliction of so severe an injury as a double amputation might probably extinguish life at once; and, if it were possible to wait after the removal of the first limb, until the shock of the operation had passed off, before the second was amputated, it might be desirable to do so; but if the patient were not too much depressed, the simultaneous or rather rapidly consecutive double amputation would probably be the safer course.

STUMPS.

On examining the *Structure of a Stump*, after a year or two have elapsed from the time of its formation, it will be found to be composed of a mass of fibro-cellular tissue, the muscular and tendinous structures that enter into its formation having become thus transformed. The ends of the bones will be found to be rounded, and the medullary canal filled up, the vessels being obliterated up to the nearest collateral branch (Fig. 12). The ends of the nerves are thickened, and commonly assume a bulbous appearance (Fig. 13). On examining these rounded or oval tumors, they will be found to be fibro-cellular masses, having nervous fibrillæ thinly scattered throughout.

The proper adaptation of **Artificial Limbs** is a matter of considerable consequence; and the ingenious mechanical contrivances that are at the present day adapted to stumps, leave little to be desired. The Surgeon had better leave the details of these mechanical contrivances to the instrument-maker; but he should see that they are made light, consistently with sufficient strength and support, and that the end of the stump is never pressed upon by them. Thus, after amputation of the thigh, the artificial limb should take its bearing point from the lower part of the pelvis and hip. In amputation immediately below the knee, this joint should be bent and received into the socket of the instrument; and if the amputation be at a lower point than this, and the stump be extended into the artificial limb, its end must be protected from injurious pressure. Even in the case of disarticulation at the ankle-joint, where the soft tissues of the heel are left, pressure can seldom be borne upon the end of the stump.

Fig. 12.—Artery of Thigh-Stump laid open.

Fig. 13.—Nerve in a Stump of Forearm.

Morbid Conditions of Stumps.—*Necrosis.*—It not unfrequently happens that the end of the bone in a stump dies. Most commonly this is the consequence of inflammation (osteo-myelitis) set up in that portion of the bone which is left in the stump, as the result of which its vitality is lost, and necrosis sets in; or it may occur in consequence of the injury inflicted by the saw. This is especially apt to happen in persons of feeble constitution, in whom the limb has, previously to the operation, been the seat of abscess that has denuded the bone or otherwise injured its vitality. In these cases a fistulous opening will be left leading down to the necrosed bone, which usually separates three or four months after the operation in the shape of a complete ring, with irregularly spiked prolongations stretching from its upper part (Fig. 14); after this has been removed, the stump becomes firmly consolidated. The lower part of such a sequestrum is thick and annular, and includes the whole thickness of the bone. It is smooth externally, where it has been covered by the periosteum. About an inch above this it becomes thinner, and is composed of the innermost part of the bone—that which surrounds the medullary canal. Then it is roughened externally, where it has separated from the adjacent healthy bone; and above this it is spiculated and very irregular, becoming gradually thinner. In some cases the spiculated part is very sharp-edged; in others, as in Fig. 14, it is somewhat smoothed by long contact with the pus that has surrounded it.

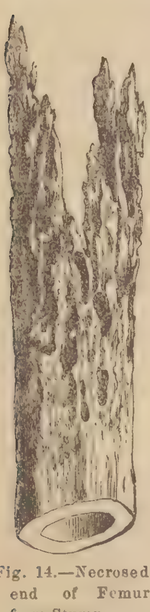


Fig. 14.—Necrosed end of Femur from Stump.

Conical or "Sugar loaf" Stumps, as they are called, commonly form, either in consequence of the flaps having originally been cut too short, or from the bone not having been sawn off sufficiently high above the

angle of the flaps: but in other cases they may occur, though the stump has been skilfully fashioned, in consequence of the soft parts, which have been the seat of inflammatory action and suppuration before the amputation, retracting during the granulating process so as to denude the bone. In such cases as these, great retraction and contraction of the flaps are apt to go on during cicatrization, so that the bone may never be covered at all, but be exposed at the bottom of an irritable ulcer; or, if the soft parts do coalesce, the cicatrix will be unable to support the slightest pressure without becoming ulcerated. In these circumstances, the only remedy consists in laying open the stump, and cutting off about three inches of the bone.

If the stump be too long and projecting, so as constantly to be in the patient's way, there is no remedy but to perform a second amputation higher up. This is especially required in badly fashioned stumps of the leg, where the limb has been removed too far below the knee, so that it projects backwards in an awkward manner, and is constantly liable to accident when the patient uses a wooden pin. But these reductions of badly fashioned stumps should not be lightly undertaken, for the mortality is great after such operations.

Fig. 15.—Aneurismal Varix in a Stump.

Aneurismal Enlargement of the arteries of a stump is extremely rare. The only case with which I am acquainted is one described by Cadge, in which an aneurismal varix between the posterior tibial artery and veins formed in a stump after disarticulation of the ankle joint (Fig. 15, *a*).

Painful and Spasmodic Stumps.—The nerves in a stump naturally become somewhat expanded and bulbous; and no material inconvenience results from this condition. But it occasionally happens that a distinct tuberose enlargement forms in connection with one of them, and attains the size of a cherry or a walnut; and, this being pressed against the end of the bone, the stump becomes the seat of intense pain of a neuralgic character, more particularly whenever it is touched, when a sensation like an electric shock is felt. In such circumstances, excision of this bulbous extremity of the nerve, or resection of the stump so as to remove the end of the bone and the whole of the cicatrix, is necessary, and will effect a cure. Sometimes a nervous twig may become implicated in, and compressed by, the cicatrix. Here a more limited excision will remove the pain. Besides this form of painful stump, which may happen in the strongest and healthiest subjects, and is entirely dependent on local causes, there is another condition in which the stump becomes not only the seat of intense pain, but of continuous convulsive twitchings. This form of painful stump arises from constitutional causes, and most frequently occurs in females, more particularly in those who are of the hysterical temperament, and are or have been subject to neuralgic pains elsewhere. In these cases the general cutaneous sensibility of the stump is increased; it is the seat of convulsive jerkings or twitchings, and the pain is more or less intermittent, being increased under the influence of various emotional and constitutional causes. In such cases, the treatment should be conducted on the general principles that will be fully

discussed when we come to speak of neuralgia. No excision of the nerves of the stump, or even amputation higher up, is of any avail; the disease, being constitutional, will certainly return in each successive stump, until at last the shoulder or the hip may be reached without any permanent benefit to the patient.

Occasionally after amputation a condition of chronic or subacute neuritis, with sclerosis of the nerve, is set up, which has a tendency slowly but steadily to extend itself upwards, involving new nerves as it goes, and finally, perhaps, leading to changes in the spinal cord itself. The symptoms and treatment are those of chronic neuritis, which will be fully described under Injuries of Nerves.

Strumous or Malignant Degeneration may occur in a stump, presenting the ordinary characters of these affections met with elsewhere. In the strumous stump, secondary amputation may advantageously be performed; but on the recurrence of malignant disease it is seldom justifiable, as there is probably deposit in internal organs or contamination of the lymphatics.

Fatty Degeneration of the muscles of a limb, arising from their disuse, gives rise to a peculiar appearance in the stump. During the amputation, the muscles look like pieces of yellow wax, and are firm; no atrophy, so far as size is concerned, has taken place; the fat being deposited between the muscular fibres, producing atrophy of them by its pressure, and occupying their place, so that the general size of the limb and fulness of the stump are preserved. Union takes place in these circumstances, though somewhat slowly; at least, this has occurred in several cases in which I have observed this condition. In one of these I amputated the leg for disease of the foot of nine years' standing, and in another the thigh for disease of the knee of fourteen years' standing.

MORTALITY AFTER AMPUTATION.

The general causes of death after operations have already been considered; but we must now examine some special points connected with the relative mortality after amputations of different kinds, and the cause of the difference that exists. The principal causes of death after amputation are the influence of shock, the occurrence of secondary hæmorrhage, pyæmia, septicæmia, erysipelas, phlebitis, and congestive pneumonia; besides these, hospital gangrene and sloughing of the stump occasionally carry off the patient. Pyæmia is the most frequent cause of death after amputations, nearly one half of the patients that die perishing from this disease. Bryant has shown that, at Guy's Hospital, it is fatal in ten per cent. of all amputations, and in forty-two per cent. of fatal cases, and that it is most frequent after amputations through limbs, the tissues of which are in a normal condition, and where a large surface of healthy bone is exposed, as in amputations for injury, and in the removal of limbs for tumors, talipes, ankylosis, &c. It is not so common after amputations performed for chronic joint-disease. Shock is a frequent cause of death after primary amputations of the larger limbs.

The circumstances which more specially influence the general result of amputations, as well as the particular cause of death after the operation, may be divided into two classes:—α. Those that have reference to the general constitutional condition of the patient. β. Those that are connected with the operation itself.

α. To the first class may be referred 1, *Age;* 2, *General Health;* and 3, *Hygienic Conditions.*

1. **Age** exercises a material influence on the result of amputations. As a general rule it may be stated that, the younger the patient, the greater the likelihood of a successful result. At early periods of life, also, there is a great exemption from low secondary diseases of the septic type; and if death occur, it is usually from exhaustion or intercurrent visceral mischief. At advanced periods of life, amputations, whether for accident or disease, are amongst the most fatal operations in Surgery, more especially when the lower extremity is the seat of operation. Then, indeed, recovery can scarcely be looked for.

2. The **General Health** of the patient previous to the operation exercises necessarily a most powerful influence on the chances of recovery. The state of the kidneys, more especially, is of great importance in this respect; for no condition tends more certainly to a fatal termination, than a chronically diseased state of those organs. The results of amputation are also necessarily widely different, according as the operation is practised on the healthy inhabitant of a country district, or on the cachectic and debilitated denizen of a large town. The causes of death also differ in these cases. In the country, hemorrhage or acute inflammation; in towns, exhaustion and septic diseases, commonly lead to the fatal result. And undoubtedly shock and septic diseases are the two principal causes that determine death after amputation.

The influence of *Shock* and of *Septic Disease* is very differently felt in different amputations. The greater the portion of body that is removed the more severely is shock felt. In these cases, also, the influence of septic agencies becomes more marked. This is owing to two causes: 1. The depression of the nervous system consequent on the shock, and on the loss of blood that is the frequent accompaniment of a great operation, tending to lower the resisting power of the system to all noxious influences, and thus predisposing to septic absorption, constitutional or local; and, 2. The large surface of wound exposed, rendering local contamination more likely to occur.

The influence of shock and septic disease in amputations is well marked. Out of 80 consecutive cases occurring at University College Hospital, which form the basis of these observations, there were 3 deaths from shock (all primary), and 10 from pyæmia and erysipelas; leaving only 8 deaths to be accounted for by exhaustion and the other minor and more varied causes that I have mentioned.

Out of a total of 631 amputations occurring in metropolitan hospitals, in which 239 deaths occurred, 110 died from shock and pyæmia together, being 17·5 per cent. of the whole operated on, or 46 per cent. of the total deaths—and this is irrespective of those that are reported as dying of "exhaustion," which is closely allied to shock, or from "erysipelas," "low cellulitis," and forms of septic disease other than pyæmia. This terrible disease proved fatal in as nearly as possible 36 per cent. of all the deaths, and shock in about 10 per cent. of the deaths, or in 3·8 per cent. of all the amputations.

But the respective influences of these two great causes of death after amputations will be found not only to vary greatly, according as the operation is primary, secondary, or for disease, but also to exercise very different degrees of influence in different hospitals.

Shock was most felt in primary amputations, in the proportion of 25 per cent. of the deaths, was but little fatal in secondary amputations, 6 per cent.; and was entirely absent as a cause of death in pathological amputations.

Pyæmia was fatal in about one-third, or 33 per cent., of the primary amputations, and in 44·4 per cent. of the secondary; and in those for disease it again acquired nearly the level of the primary—viz. 34·6 per cent.

Pyæmia is proportionally more fatal after amputations of the upper than of the lower extremity, occasioning about 40 per cent. of the deaths in the former, against 34 per cent. of the latter, after amputations for all causes. In primary amputations the disparity is more marked, being about 50 per cent. of all deaths in the upper, against about 32 in the lower limb; shock, on the other hand, being more fatal by far after primary amputations of the lower than of the upper extremity, owing doubtless to the larger mass removed.

The influence of *shock* is necessarily most felt in primary amputations. Indeed, its fatal results are almost entirely confined to amputations performed within twenty-four hours of the infliction of the injury. I have never known a case of intermediate or secondary amputation, or amputation for disease, in which the patient died from this cause. Fatal shock, in fact, is the result of the combined depressing influence of the injury and of the operation. It occurs in exact proportion to the severity of the injury, the amount of loss of blood, and the age of the patient. It is often rather referable to the injury than to the operation; and it becomes a question whether, in many cases of serious and almost hopeless smash of a limb, it might not be better to let the patient expire in peace, than subject him to the repetition of a shock which his nervous system will be utterly unable to endure. This is more especially the case in extensive crush and disorganization of the lower extremity up to or above the middle of the thigh, such as are not unfrequent at the present day from railway accidents, in which the mangling of the limb rather resembles that produced by cannon-shot than by an ordinary injury of civil life. In these cases amputation through the upper third of the thigh, or at the hip-joint, is the only available operation. It is usually done in such cases. But is it ever successful in the full-grown adult? That is a question which deserves the serious consideration of hospital surgeons. I am not acquainted with a single case in which such an operation has succeeded in general hospital practice, in men who have arrived at full maturity. In children and young adults it has proved successful. The three cases in which it was done, out of the eighty University College cases, all died of shock. The same catastrophe has happened in every other case on record with which I am acquainted. It is an operation that has been abandoned by military surgeons in cases of compound comminuted fracture of the femur from bullet-wound in this situation; ought it not to be equally discontinued by civil surgeons in those more hopeless cases of utter smash of the limb that occur in their practice? For my own part, I shall never again, except in children and young people, amputate in that situation for such injuries—hopeless alike, whether left or subjected to the knife; but surely better for the patient to be left to die in peace than to be again tortured by amputation, which all experience has shown to be useless.

It is of importance to observe, in reference to these cases of death from shock after primary amputations, that the fatal result happens in a few hours, usually within twenty-four, of the performance of the operation. Hence, although it may be disposed to by the previous condition of the patient, and the influence exercised upon his powers of endurance by the severity of the injury, the loss of blood, his age, &c.—for death from shock necessarily occurs more frequently under similar

conditions of injury at advanced than at early periods of life—or even by season of year, yet it cannot in any way be affected by the conditions to which the patient is exposed subsequently to the performance of the operation, so far at least as hospitals or other external influences are concerned. We must, therefore, look upon death from shock as a part of the general accident to which the patient has been exposed and of the injury that he has sustained, aggravated, doubtless, by the further depressing influence exercised by so serious an operation as an amputation possibly high up in one of the limbs. It is interesting to observe that season exercises an influence on the liability to death from shock after primary amputations. According to Hewson, of Philadelphia, it is most fatal in winter. The reason is obvious: the cold, to which the sufferer has been exposed at the time of the occurrence of the accident for which he has to undergo an amputation, is an additional cause of vital depression.

If, therefore, we want to lessen the mortality consequent on these operations, the first point to look to is not to amputate needlessly in hopeless cases of smash of the thigh high up, in order to give "a last chance" to a patient whose vital powers have already been depressed to the lowest ebb by a fearful mutilation. Such amputations, which sometimes consist in little more than the severance of a limb still attached to the trunk by shreds of muscle, ought scarcely to find their way into a statistical table professing to give the general results of operations the majority of which are more deliberately performed, and with a better prospect of success. They ought, in point of fact, to constitute a class of cases apart, in which the operation is subsidiary to the injury that has preceded and that leads to it; the more so, as they are frequently complicated with the internal injuries which are not detected until after the death of the patient.

Shock, as has already been shown, exercises its influence chiefly in primary amputations; far less in secondary ones; and disappears entirely, as a cause of death, in pathological amputations. There, however, it is replaced by "exhaustion." This condition stands in the same relation to amputations for disease that shock does to those that are practised for injury. Death by "exhaustion" or "collapse" is, in fact, an indication that the impression produced by the operation on the nervous system has been greater than the already enfeebled powers of the patient were able to endure; and the frequent occurrence of these terms, as indicating the cause of death in any table of amputation statistics, may be taken as evidence of the operation having been practised too often, when the patient was already so enfeebled by long-continued disease, or so exhausted by discharges and suffering, as to be unable to support the additional depressing influence of a serious surgical operation. In the returns of Dr. Chadwick of the results of amputations in the Massachusetts General Hospital, Boston, "exhaustion" is stated to be by far the most frequent cause of death. Out of the 180 fatal cases, it is returned as the cause of death in 98, or 54·4 per cent.; whilst "collapse" is stated to have been fatal in 21, or 11·8 per cent., and "shock" in only 2 cases. I cannot but think that these terms are here used in a somewhat different sense from that in which we employ them, and that they rather represent what we should call "shock." However this may be, the fact is certain that in these Boston cases no fewer than 122 deaths out of 180, or 67 per cent., occurred from causes that were altogether independent of any septic hospital influence, a state of things that speaks highly for the sanitary condition of the hospital.

The next and by far most important of all the causes of death after operations in hospitals, is undoubtedly the development of *septic disease*. The importance of this is obvious, from a consideration of the following statistics. Out of the 21 deaths that occurred in the 80 University College amputations, no fewer than 10, or nearly one-half, arose from this cause; and, out of a grand total of 239 deaths occurring in four metropolitan hospitals, 86 died from pyæmia alone, without including other septic diseases and secondary septic visceral inflammations; there being nearly four times as many deaths from pyæmia as from shock.

Dr. Chadwick, in the report of the Massachusetts General Hospital, returns 42 deaths from pyæmia out of the 180 fatal cases that occurred in 692 amputations of all kinds, being in the proportion of 23·3 per cent. on the deaths, and only of 5·7 per cent. on the whole number of amputations —a most remarkably low percentage of septic mortality, of which it may be taken as the whole and sole representative, there being no deaths returned from erysipelas or any other hospital disease.

β. The circumstances connected with the operation itself that influence materially its result are, 1. The *Seat* of the amputation. 2. The *Structure of the Bone* sawn. 3. Whether the operation is done for *Injury* or *Disease*. 4. If for disease, the *Nature* of the affection. 5. If for injury, the *Time* that has elapsed before the limb is removed.

1. With regard to the influence of the **Seat** of amputation on the result of the operation, it may be stated as a general rule, that the risk is greater in proportion as the size of the part that is amputated increases, and as the line of amputation approaches the trunk; in fact, the nearer it is to the trunk, the greater is the danger.

It needs no formal argument to show that the amputation of the toe or of the foot is less hazardous than that of the leg or the thigh. The subjoined table, derived from the examination of statistics of amputation in civil practice, collected from various British, Continental, and American sources, shows clearly the increase in the ratio of mortality as the operation approaches the trunk.[1]

SEAT.	CASES.	DEATHS.	PER CENT.
Shoulder-joint	117	58	49·5
Arm	1319	375	28·4
Fore-arm	1059	109	10·2
Hip-joint	46	19	41·3
Thigh	3477	1224	35·2
Leg	3006	985	32·7

If we turn to the statistics of military surgery, we find similar results. Thus, in the British Army in the Crimea the percentages of death were, after amputation of the fore-arm, 7; of the upper arm, 19; of the shoulder-joint, 35; of the foot, 16; of the leg, 37; of the knee, 57; of the thigh, 64; and of the hip, 100; figures most creditable to the skill of the surgeons employed, but showing the progressive tendency to increase with the size of the limb removed. In the French army in the Crimea, the

[1] The numbers referred to in this Chapter have been derived in great part from the Tables published by Mr. James Lane in the first volume of the last edition of Cooper's *Surgical Dictionary;* Sir J. Y. Simpson's paper on Hospitals, in the *Edinburgh Medical Journal* for June, 1869; various statistical papers in the Reports of Hospitals; M. Chenu's elaborate special returns on the medical service of the French army in the Crimean War, and in the Italian Campaign; and the official reports issued by the Surgeon-General of the United States Army regarding the War of the Rebellion.

percentage of mortality after amputation of the fore-arm was 45; of the arm, 55; of the shoulder-joint, 61; of the foot, 76; of the leg, 72; of the knee-joint, 91; of the thigh, 92; and of the hip, 100. In the Italian campaign of 1859, the percentages of the mortality in the French army—including in some cases operations on wounded Austrians—were: fore-arm, 42; arm, 56; shoulder-joint, 55; foot, 55; leg, 70; knee-joint, 75; thigh, 78; hip-joint, 57. In the war of the American rebellion the percentages of mortality were as follow, showing markedly how rapidly it runs up in accordance with the size of the part removed: fingers and hand, 1·6; wrist, 5·5; fore-arm, 16·5; arm, 21·2; shoulder, 39·2; partial of foot, 9·2; ankle-joint, 13·4; leg, 26; knee, 55; thigh, 64·4; hip, 85·7.

Not only is there this increase in the rate of mortality as the operation approaches the trunk, but in the larger limbs, more especially in the thigh, every additional inch that is removed appears to make a difference in this respect. Thus, in our army in the Crimea, of 178 amputations of the thigh, 44 were in the upper third, and of these 38, or 86 per cent., proved fatal; 68 were in the middle third, and of these 41, or 60 per cent., died; whilst in the lower third the mortality out of 66 cases was 37, or 56 per cent. In the French army in the Crimea, according to Chenu, of 81 amputations of the thigh at the upper third, 37, or 60 per cent., died; in 91 amputations at the middle third, there were 63 deaths, or 69 per cent.; and in the lower third there were 101 cases, with 59 deaths, or 58·4 per cent. In the Italian campaign of 1859, according to the same authority, there were 46 cases of amputation of the thigh at the upper third, with 43 deaths, or 93 per cent.; 52 at the middle third, with a mortality of 44, or 84 per cent.; and 43 at the lower third, with 36 deaths, or 83 per cent. Again, among 21 amputations of the humerus at the neck in the French army in the Crimea, the mortality was 9, or 43 per cent.; in 229 at the upper third, it was 62, or 27 per cent.; in 145 at the middle third it was 27, or 18 per cent.; and in 55 at the lower third it was 6, or 11 per cent.

Not only do the size of the part removed, and its proximity to the trunk, influence materially the general mortality after amputation; but these conditions also influence the particular cause of death. Thus after the smaller amputations, as of a toe, for instance, death occurs only in unhealthy states of the constitution, from the occurrence of erysipelas, or of some of the various forms of diffuse inflammation. Death after the larger amputations more frequently results from causes connected with the operation itself, as, for instance, secondary hemorrhage, shock, or exhaustion by the abstraction of the large quantity of blood contained in the limb, as well as by that lost during the operation. After the removal of the whole of a limb, as in the case of amputation at the hip-joint, it is possible that the cause suggested by Cox, viz., the removal of a limb in which the blood undergoes changes of importance to the rest of the economy, may materially affect the result.

2. The **Part of the Bone** that is sawn through may influence the result. Amputations through the cancellous ends of long bones are less dangerous, in one respect, than those through their shafts, in consequence of the medullary canal not being opened when the section is made near the articular end, so that the liability to diffuse suppuration of this cavity, and consecutive phlebitis and pyæmia, is diminished.

3. The mortality resulting from amputations is perhaps more directly influenced by whether the operation is done for **Injury or Disease**, than by any other cause, being far greater in corresponding limbs after injury

than disease, except as regards amputation of the fore-arm. In the following table may be seen the results of 307 consecutive cases of amputation performed at University College Hospital up to May, 1871. Of these 307 cases, 79 died, yielding as nearly as possible a mortality of 25 per cent. Since the publication of these, 80 additional amputations have been performed up to May, 1873. Of these 387, exactly 100 have died, being at the rate of 25·8 per cent. The rate of mortality has throughout, under many different modes of treatment, been singularly steady, ranging between 23·5 and 25.5 per cent.

RESULTS OF AMPUTATION IN UNIVERSITY COLLEGE HOSPITAL.

Amputation for Injury.

SEAT OF AMPUTATION.	CASES.	RECOVERIES.	DEATHS.	PERCENTAGE OF DEATHS.
Thigh	39	16	23	59·0
Leg and Foot	44	30	14	31·8
Shoulder and Arm . . .	12	7	5	41·6
Fore-arm	8	8	0	0
Total	103	61	42	40·7

Amputation for Disease.

SEAT OF AMPUTATION.	CASES.	RECOVERIES.	DEATHS.	PERCENTAGE OF DEATHS.
Thigh	86	68	18	20·9
Leg and Foot	74	64	10	13·5
Shoulder and Arm . . .	24	16	8	33·3
Fore-arm	20	19	1	5·0
Total	204	167	37	18·1

Malgaigne's statistics from the Parisian hospitals illustrate this matter in an equally clear point of view, as will be seen in the following table.

SEAT.	*Injury.*			*Disease.*		
	CASES.	DEATHS.	PER CENT.	CASES.	DEATHS.	PER CENT.
Thigh	46	34	74·0	153	92	60·0
Leg	79	50	63·3	112	55	49·0
Foot	9	6	66·6	29	3	10.3
Arm	30	17	56·6	61	24	60·0

The following table gives the result of numerous cases in civil practice, collected from various sources. (See note, page 78.)

SEAT.	*Injury.*			*Disease.*		
	CASES.	DEATHS.	PER CENT.	CASES.	DEATHS.	PER CENT.
Thigh	964	576	59·7	1465	477	32·5
Leg	771	356	46·1	1281	301	23·5
Arm	514	180	34·4	250	65	26·0
Fore-arm	360	38	10·5	151	23	15·9

The *shock* inflicted by the injury, with its subsequent evils, appears to be one of the principal reasons of the greater mortality after amputations for injury than after those for disease. After amputation for injury, also, there is a greater liability to the occurrence of gangrene of the stump, and pyæmia and its secondary effects, than in the case of the removal of a limb for disease; in which the principal causes of death usually appear to be exhaustion, and the supervention of disease of the lungs. In amputation in cases of disease, it will be found that those patients do best in whom the disease is most chronic. This is especially observable in cases of disease of bones and of the joints.

4. The **Nature of the Disease** for which the amputation is performed influences its mortality. Thus amputations for malignant disease are more fatal than those for caries of bone or diseased joints. In cases of diseased joint, there is a greater tendency to recover when the affection is of a simple than when it is of a tuberculous nature. Birkett has pointed out that disease of internal organs, often of the same nature as that for which the operation is performed, is found after death in a large proportion of patients who die after amputation. When suppurative disorganization of a joint is very acute, amputation, more particularly if the affected articulation be of large size, as the knee, is attended by very unfavorable results. The tendency to pyæmia is very strong in such cases, the blood being loaded with effete materials, the products of the inflammatory action, which are specially apt to run into suppuration, both in it and in the tissues generally. But when the disease has once become chronic, the precise period at which the amputation is performed exercises but little influence on the mortality, provided it be not deferred to too late a stage, when the patient's constitution is worn out by hectic.

Amputations of expediency—those performed for the convenience of the patient, as in cases of talipes or ankylosis, but not necessary, so far as life is concerned—are especially fatal. Bryant has shown that, at Guy's Hospital, death has followed in 40 per cent. of these amputations of the lower extremity.

5. In amputation in cases of injury an important question has to be determined, viz., the influence exercised by the **Time** that has elapsed from the infliction of the injury to the performance of the amputation. Not only the rate of mortality, but the conditions that immediately occasion the fatal event, are influenced by the period at which the operation is performed.

Amputations for injury are commonly divided by surgeons into *Primary* and *Secondary;* the *primary* being those that are performed during

RESULTS OF PRIMARY AND SECONDARY AMPUTATIONS IN CASES OF INJURY, AT UNIVERSITY COLLEGE HOSPITAL.

SEAT.	*Primary.*		*Secondary.*	
	CASES.	DEATHS.	CASES.	DEATHS
Thigh	14	8	21	14
Leg and Foot	22	8	16	3
Shoulder and Arm . . .	6	2	5	2
Fore-arm	6	0	1	0
Total	48	18	43	19

the first twenty-four or thirty hours, before any inflammatory action in the part injured has taken place. By *secondary* amputations, many

Primary = before inf
Secondary = after
intermediate = secondary before suppuration

Surgeons mean those operations that are practised after the first twenty-four hours; whilst others again restrict the term to those that are done after suppuration has been set up in the limb, calling those amputations *intermediate* that are performed between these two periods, viz., from the twenty-fourth hour to the occurrence of suppuration, and which consequently occupy a very extensive range. I think, however, that this distinction is somewhat trivial, and not very easily applied in practice; and that it is better to include under the term *secondary*, all amputations performed after inflammatory action has been set up in the injured part.

The subjoined table, collected from various sources, shows the relative results of primary and secondary operations in civil practice.

SEAT.	*Primary.*			*Secondary.*		
	CASES.	DEATHS.	PER CENT.	CASES.	DEATHS.	PER CENT.
Thigh	235	153	65·1	156	85	54·4
Leg	405	178	43·9	150	72	48·0
Arm	276	79	28·6	75	32	42·0
Fore-arm . . .	190	16	8·4	27	6	22·2
Total . . .	1106	426	38·5	408	195	47·7[1]

While the percentage of deaths after primary amputation of the thigh exceeds that after secondary amputation, the rate of mortality in amputations of the leg, fore-arm, and arm is greater after the secondary than after the primary operation, especially in the upper limb. Primary amputation of the thigh is, indeed, one of the most fatal operations in Surgery. Thus of 46 cases of primary amputation recorded by Malgaigne, 34 perished; of 18 cases in the Massachusetts Hospital at Boston during the five years 1863—1868, 15 died; 9 cases out of 10 died at the London Hospital during the years 1863—1866; and of 24 cases recorded by South, Lawrie, and Peacock, as occurring at St. Thomas's Hospital, the Glasgow Infirmary, and the Edinburgh Infirmary, every one perished. The danger of amputation of the thigh for injury is increased in proportion to the height at which the limb is severed. It is least in those cases where the operation is done for injury of the leg or knee-joint, and greatest when it is performed for compound fracture of the femur, recovery from which is very rare. This excess of mortality after primary amputation of the thigh must be referred mainly to the intensity of the shock, whether produced by the operation itself, or, more often, by the injury which has rendered its performance necessary. The sudden disturbance of the balance in the supply of blood, caused by the removal of so large a portion of the body, may also contribute to the danger. In primary amputations of the leg, arm, and fore-arm, however, the influence of these causes is relatively less, while in secondary amputations of these parts, as well as of the thigh, shock is much less intense. In these, the chief danger arises from pyæmia, gangrene, diffuse inflammation, secondary hæmorrhage, and all those morbid conditions that are favored by defective hygienic circumstances, and which appear to exercise a more uniformly unfavorable influence over the secondary amputations than shock does over the primary.

[1] The reader who wishes to pursue this subject further will find a very large body of statistics on the results of amputations in the last edition of Cooper's *Surgical Dictionary*.

The following are the main causes of death after amputations, as published in the Reports of four Metropolitan Hospitals up to 1871. In 187 primary amputations, 90, or 48·6 per cent., died; of these 90 deaths, 21 occurred from shock, and 30 from pyæmia. In 84 secondary amputations, 50, or 59·5 per cent., and of these only 3 perished from shock, whilst 22 were the victims of pyæmia. In 350 amputations for disease, 98, or 27·4 per cent., died; of these none were destroyed by shock, but 34 by pyæmia[1]

In military practice, secondary amputation is, in general, more fatal than primary. Thus, Faure saved only 30 out of 300 secondary amputations, whilst Larry saved three-fourths of those in which he amputated primarily. In the Peninsular war, the mortality after secondary amputation of the upper extremity was twelve times, and after secondary amputation of the lower limb, three times, as great as after primary amputation of these parts. In the British army in the Crimea, from the 1st of April to the close of the war, the relative rates of mortality per cent. after primary and secondary amputations were as follows:—After *primary* amputations at the shoulder, 26; of the arm, 17; of the fore-arm, 3; of the thigh, 62; of the leg, 30; and of the foot, 17; after *secondary* amputations at the shoulder, 66; of the arm, 31; of the fore-arm, 28; of the thigh, 80; and of the leg, 76. Or, for the upper extremity, the whole rate of deaths after primary was 15, against 41 after secondary amputations; whilst, for the lower extremity, excluding the foot, it was 46 for the primary, against 78 per cent. for the secondary.

In the American army during the war of the rebellion, the mortality after primary amputation of the thigh was 54·13 per cent.; and after secondary amputation, 74·76. In the French army in the Crimea, on the other hand, the mortality after primary amputation of the thigh and arm—amounting in the former limb to above 90 per cent.—was greater than that after the secondary operation.

As has already been observed, not only does the *rate* of mortality differ in primary and secondary amputations, but also the *cause* of death. Primary amputations are most frequently fatal from shock, hæmorrhage, and exhaustion, although death from pyæmia and secondary diseases of a low type is by no means rare in these cases. Secondary amputations for injury most commonly carry off the patient by the supervention of septic diseases. Amongst these secondary affections that are of most frequent occurrence, gangrene of the stump stands in the first place, especially after traumatic amputation of the thigh, and more particularly if the limb have been in a similar condition before the amputation. Then, again, erysipelas, phlebitis with pyæmia, secondary hæmorrhage, and some of the low forms of visceral inflammation or congestion, as pneumonia, pleurisy, and diarrhœa, often produce death. Pyæmia, complicated by congestive and suppurative pneumonia, is the most frequent cause of death after secondary amputation of the leg and arm. Secondary hæmorrhage to such an extent as to prove fatal is of very rare occurrence; when it happens, it is usually associated with some diseased state of the blood interfering with the formation of a plastic plug in the artery.

Summary.—On reviewing the whole subject of the cause of death after amputations, we cannot but come to the conclusion that the mortality after amputations is influenced more directly and distinctly than that of any other operation, except perhaps ovariotomy, by the hygienic condi-

[1] "Hospitalism," &c., p. 20.

tions to which the patient is subjected after the operation. The evil influences arising from exposure to a vitiated atmosphere—to those various conditions and combinations of conditions that are summed up under the one general term "*Hospitalism*,"—exercise so important a bearing upon the death-rate after amputation, that, in order to arrive at a just estimate of the probable chances of recovery after any given amputation, it becomes necessary not only to consider whether the operation be done for injury or disease—whether it be primary or secondary—whether the disease be simple or malignant—whether the patient be aged or young, healthy or diseased; but, above all, to consider whether, after the removal of the limb, the patient will be exposed to those conditions that result from the aggregation of the sick and wounded. For it is on them almost more than on any others that the ultimate result will depend.

Whatever explanation we may give of the fact, it remains certain and incontrovertible that the rate of mortality after amputation of all limbs in the large city hospitals of Great Britain up to a very recent period has been at least 1 in 3 (*vide* Table). In those of Paris, out of 1,656 amputations, the statistics of which were collected by Malgaigne and Trélat (Simpson), 803 died, or nearly 1 in 2 (*vide* also Table). The Government statistics collected by Bristowe and Holmes show that in 1861 the amputation death-rate in Parisian hospitals was 3 in 5, and more recently Le Fort gives the mortality at 58 per cent. In Germany matters were not much better. Billroth's published amputation-mortality has been from 43 to 46 per cent. In the United States the death-rate is much smaller, however, the mortality in the Pennsylvania Hospital being only about 24 per cent., and that of the Massachusetts General Hospital 26 per cent.

In military practice, the result of the experience deduced from the mortality following amputations during the great modern wars is at least equally unfavorable. But here there are so many modifying and disturbing elements, that it may be well to exclude these cases from consideration.

In fact, then, on taking the average mortality after amputation of all four limbs in the largest hospitals in the great centres of civilisation, we come to this result, that it commonly varied from 60 to 35 per cent., and did not fall below 24 per cent.; and that in certain of the larger amputations, as in the upper third of the thigh and at the hip-joint, it ran up to from 70 to 90 per cent. Widely extended statistical returns have shown but too plainly that these figures are trustworthy and constant, when founded on sufficient numbers and carried over a sufficient length of time to eliminate the influence of accidental circumstances operating for or against the patient.

So constantly do these figures come out in hospital returns, that Surgeons had almost come to regard them as representing the necessary, or, so to speak, the *natural* rate of mortality after amputations. But is this so in reality? Is this frightful rate of mortality the necessary result of the operation, and thus beyond our control? or is it dependent on causes that are preventable, and that may in great part, if not wholly, be removed? That it is not necessary—that it is dependent on preventable causes and will eventually be more materially diminished—is evident from the admirable results that have of late years been obtained by Callender, Lister, Spence, and others, by different methods of treatment, but all having in view attention to the hygienic conditions of the wound and of the patient.

Up to a recent period, Surgeons have had no opportunity of obtaining

a knowledge of the results of amputations on a large scale, except such as have been furnished by the statistical results obtained from hospitals. It was not until Sir James Simpson collected a large mass of statistics from small country hospitals—from private practice in manufacturing and mining districts especially, where amputation sare of common occurrence—that the important fact has been most incontestably and satisfactorily proved, that the high rate of mortality above given is not by any means the necessary and unavoidable result of amputation, but that it arises from causes independent of and beyond the operation itself; that, in fact, it is greatly dependent on the conditions to which the patient is exposed after its performance.

Simpson collected the particulars of 2,098 amputations of all kinds occurring in country and private practice in towns; of these 229 died, or 1 in 9·2; whilst of an almost equal number, viz., 2,089 amputations, performed in the large city hospitals of Great Britain, 855 died, or 1 in 2·4.

It is quite possible that Simpson's figures are not absolutely but only approximately correct, and that certain sources of fallacy have intruded themselves, more especially with regard to the condition of the patient *before* the operation, to which undoubtedly great importance must be attached (*vide* p. 75). But still, making full allowance for all this, the difference is so great between the two sets of cases, that the material result, viz., that the mortality after amputation in hospital practice was nearly four times as great as when the same operations are performed out of hospital, cannot very materially be affected, and we cannot escape from the conclusion that the high hospital mortality was greatly influenced by the exposure of the patient to those septic conditions existing in the air of large hospitals, which have been so ably and graphically described by Parkes, and which exercise the most injurious toxic effect on patients with large wounds who are exposed to them.

That those septic influences which are generated in, and which may eventually saturate hospitals, exercise a most important influence in causing fatal pyæmia, septicæmia, and osteo-myelitis after amputations, from which, as has already been shown, a large proportion of the amputated die, is evident from the following considerations.

1. From the commencement of this century up to a comparatively recent period—during what, in fact, may be termed the pre-sanitary age—no improvement had taken place in amputation-mortality in hospitals.

2. The prevailing high rate of mortality varied greatly in different hospitals in the same town, in which the patients were of the same class of society, followed pretty much the same occupations, and were subjected to the same kinds of injuries and diseases; the hospitals being officered by Surgeons of equal professional skill, and the only inequality existing being in the different sanitary conditions to which the patients were exposed in different hospitals.

3. The difference in the amputation mortality in different London hospitals varied from 18 and 25 to 47 per cent. In Calcutta, the death-rate after thigh amputations varied in different hospitals from 42 to 80 per cent. (Downie).

4. Of late years, this excessive amputation mortality has been materially reduced in some hospitals.

5. This reduction is contemporaneous with, and, *as all the other conditions continue as before*, dependent upon, the greater attention paid to hospital hygiene and the employment of antiseptics, under the improved sanitary views that are now entertained by Surgeons.

6. In military practice, the rate of mortality after amputation has been found to be in the direct ratio of the aggregation of the wounded; and death from septic influences may almost, if not entirely, be everted by their isolation.

CHAPTER III.

SPECIAL AMPUTATIONS.

There are, as has already been stated at p. 60, three distinct methods of amputating limbs, viz., the flap, the circular, and the oval. The choice of the method influences the shape, and to a certain degree, perhaps, the utility of the resulting stump. But it in no way affects the safety of the patient, which is dependent on far different and far more important conditions than the manner in which the Surgeon shapes his incisions for the removal of the diseased or injured limb (p. 74). A skilful Surgeon will be able to produce a satisfactory stump by any one of the three methods, and it is desirable that he should be able to practise all. For although, as a general rule, one method may be more applicable than another, yet exceptional cases occur at times in which it may be advantageous to depart from the method usually adopted, and employ one of the others. In fact, a Surgeon should be eclectic in his method of amputating, and select that which is most suitable to the circumstances of the case before him. As a general rule, the flap method is that to which Surgeons give the preference in this country; it is that which I generally employ, and it is, therefore, that which, with few exceptions, I consider most useful. It is the method, therefore, which I shall describe in this chapter.

In describing this or any other method of amputating, precise rules may be laid down for its performance through sound structures. But it often happens, especially in cases of injury, that the destruction of tissue is so irregular as to compel the Surgeon to depart from definite rules of practice, and to shape his flap as best he may from the uninjured soft parts. There he must rely on his own judgment. But so efficient is the moulding process of nature, that provided sufficient integumental covering be left on the muscles and bones, a stump that at first looks very irregular and perhaps somewhat unsurgical, will in a short space of time acquire a regular outline and smooth surface, and will be eventually in all respects as useful as one that may from the first have been fashioned more artistically.

Amputations of the Hand.—The **Fingers** often require amputation for injury or disease, more especially as the result of bad whitlow. In many cases the ungual phalanx becomes necrosed, and may usually most readily be removed without amputation, by making an incision through the pulp of the finger and then extracting the diseased bone, thus saving the nail and pulp, which will form an excellent end to the finger; and, if the operation be done in early childhood, a new and movable phalanx may form. In other cases, amputation will be required. This may either be done by cutting into the joint from its dorsal aspect with a narrow-bladed bistoury, running across it lightly, touching the lateral ligaments, and making the flap from the palmar

aspect (Fig. 16); or the flap may conveniently be made from the palmar surface by transfixion, and then cutting across the joint (Fig. 17).[1] In

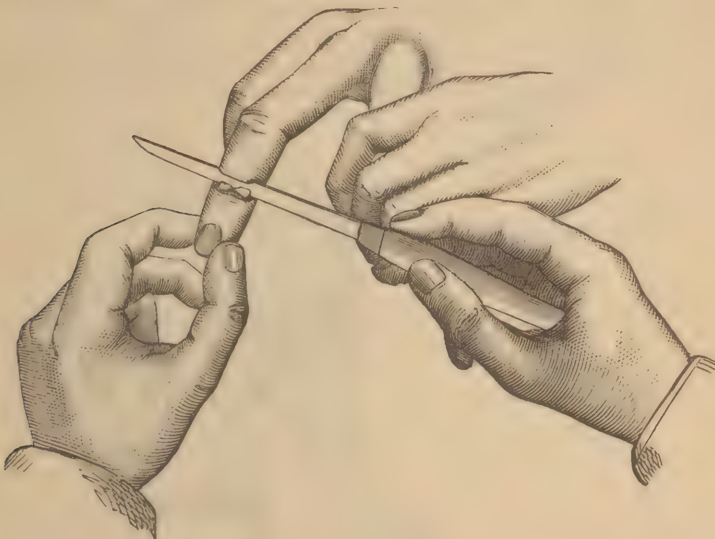


Fig. 16.—Amputation of Part of a Finger by Cutting from Above.

doing this, care must be taken to avoid cutting too far backwards, and

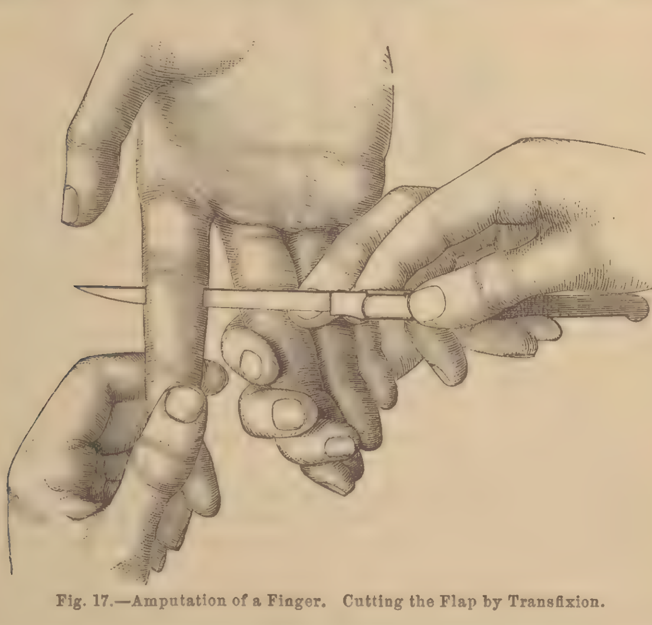


Fig. 17.—Amputation of a Finger. Cutting the Flap by Transfixion.

so mistaking the depression above the head of the second phalanx for

[1] For the Conservative Surgery of the Hand, *vide* chapter xlvii.

the articulation, which would lead to a little embarrassment. Some little difficulty is occasionally experienced in finding the joint, and Surgeons have endeavored to be guided to it by attention to the folds in the integument covering it; but in these there is no consistency, and no correlation exists between the joint and these folds in the skin. When the amputation is performed from the dorsal aspect, the finger should be flexed, when the joint will be found immediately under the apex of the

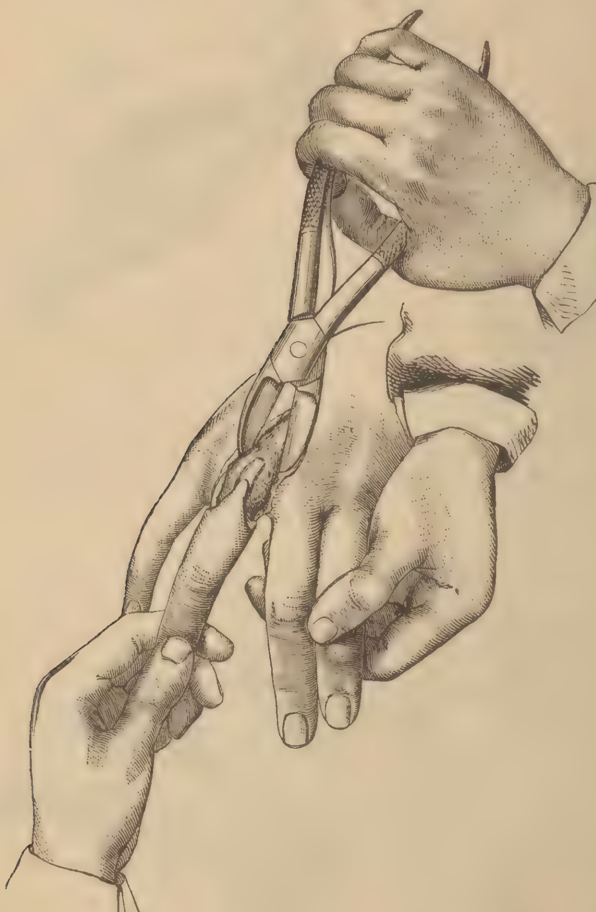


Fig. 18.—Amputation of a Finger. Removing the Head of the Metacarpal Bone.

triangle formed by the phalanges. In operating from the palmar aspect the finger should be forcibly extended as soon as the flap is made, when, if the knife be applied to the lateral ligaments, the synovial surface will show itself.

Amputation is performed between the proximal and second phalanges in the same way; but, as a general rule, it should not be done here; because, as no flexor tendon is attached to the proximal phalanx, it is apt to remain permanently extended, and a good deal in the patient's way. In the case of the index finger, however, it will be better to leave

the proximal phalanx, the stump of which forms an useful opponent to the thumb.

Amputation is frequently required at the **Metacarpo-phalangeal Articulation.** Here it may be done in two ways: either by lateral

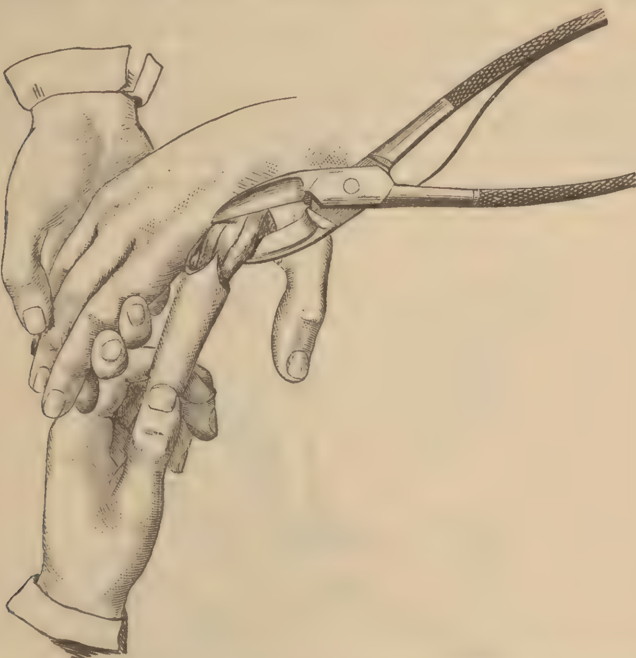
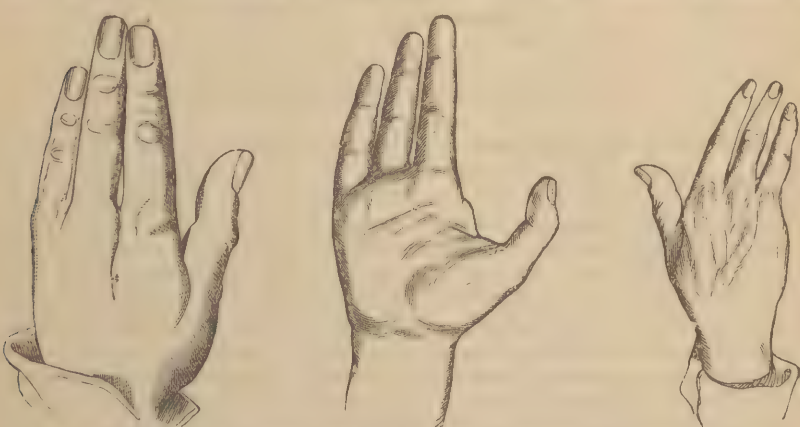


Fig. 19.—Amputation of the Index Finger. Removing the Head of the Metacarpal Bone.

flaps, or by the oval method. If by *lateral flaps*, the adjoining fingers should be well separated from the one about to be removed, by an as-



Figs. 20, 21, 22.—Results of Amputation above Metacarpo-Phalangeal Articulation in Middle, Index, and Ring Fingers.

sistant who grasps the hand, so as to put the integument on the dorsum upon the stretch. (Fig. 18.) The point of a bistoury is then entered

about three-quarters of an inch above the head of the metacarpal bone; it is then carried forwards to a point opposite the inter-digital web, drawn across the side of the finger, and then carried a little way into the palm. This same process is performed upon the opposite side, the flaps are dissected down by a few touches of the knife, the extensor tendon is divided, the joint opened, and disarticulation performed. The *oval method*, which I think is the best, as it does not wound the palm, consists in entering the bistoury at the same point as in the last case, carrying it as far as the web, drawing it across the palmar aspect of the finger, and then obliquely backwards to join the starting point of the incision. By a few touches of the point of the knife the oval flap is turned back, and the articulation opened. As a general rule, it is better to remove the

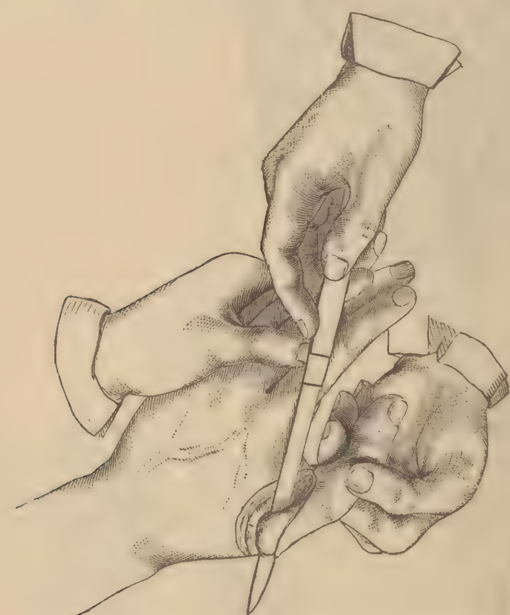


Fig. 23.—Amputation of Left Thumb and Metacarpal Bone.

head of the metacarpal bone, together with the finger; as otherwise a wide gap will be left in the situation of the finger that has been amputated, and much deformity of the hand will result. This may be done by cutting the metacarpal bone across beyond its head with bone-forceps in a transverse direction, if it be either the middle or the ring finger that is removed (Fig. 18). If it be the index or the little finger, the bone should be cut obliquely from without inwards, so as to shape it to the tapering form of the hand (Fig. 19). This may be done either with the bone-forceps or with a small saw. The saw has the advantage of making a smoother section and of leaving no splinters. If it be cut directly across, an ugly and inconvenient square protuberance, liable to constant injury, will be left. When, however, the patient's employment is one in which great strength and breadth of hand are required, and where appearance is of little consequence, the head of the bone may advantageously remain.

The after-treatment of these cases is extremely simple. The hand should be put upon a splint, the wound covered with a piece of water-

dressing, and the ends of the fingers, with small pieces of lint interposed, tied together by means of a tape, care being taken, however, that they do not overlap. The shaft of the metacarpal bone that is left will gradually atrophy, and thus a very taper and shapely hand eventually be left (Figs. 20, 21, 22).

In disease or injury of the **Thumb** as little as possible should be

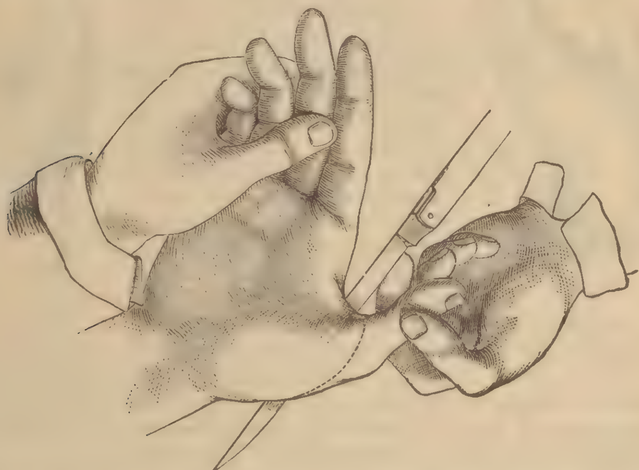


Fig. 24.—Amputation of Right Thumb by Transfixion. Cutting the Anterior Flap.

removed by amputation; for, if even but a very short stump of the metacarpal bone be left, it will serve as an useful opponent for the other fingers. When the whole thumb requires amputation, it may most conveniently be removed by Liston's method. The mode of proceeding must vary according to the side operated on. When the *left* thumb requires amputation, the point of a long narrow bistoury should be introduced well on the palmar aspect of the carpo-metacarpal articulation, carried over this, which it opens (Fig. 23), and the dorsum of the hand as far as the web of the index finger; the point of the knife should then be pushed downwards through the ball of the thumb, transfixing this and issuing where the incision commenced. During transfixion, the thumb should be slightly fixed and carried across the palm of the hand. It is next made to cut outwards, keeping close to the metacarpal bone, which is readily twisted out, the remaining attachment being separated by a few touches of the knife. An oval incision will be left, which comes together closely by a narrow line of cicatrix. In amputating the *right* thumb, it will be necessary for the Surgeon, if he adopt the method just described, either to use his left hand, or to cross his hands in an awkward manner. In order to avoid doing this, he may reverse the steps of the operation with advantage; first transfixing the ball and making the anterior flap, then cutting over the dorsum, opening the joint, and turning out the bone (Fig. 24). Fig. 25 shows the hand after amputation of the thumb.

Fig. 25.—Result of Amputation of Thumb.

The **Metacarpal Bones**, with or without the fingers supported by them, occasionally require removal for disease or injury. For these operations, which are not of a very regular kind, it is difficult to lay down definite rules; in performing them, care should be taken to make good square flaps of sufficient size, but to avoid cutting into the palm if possible. It is well not to disarticulate the lower end of the bone, so as to open the wrist-joint, but rather to cut it off with bone-forceps a little above this. In injuries from the explosion of powder-flasks or gun-barrels, when the hand is much shattered, it is of great consequence to avoid cutting up the palm to too great an extent; and it is well in these cases to save a finger if possible, which will be of more use to the patient than any artificial limb, however ingeniously constructed (Figs. 26 and 27). When only one finger is left, as the index or little finger, with the thumb, in cases of partial amputation of the hand after injury or for disease, the digit that remains not only becomes more mobile than formerly, but greatly increased in size and much stronger, so that its utility is materially augmented.

Fig. 26.—Hand after Amputation of Metacarpal Bones and First two Fingers.

Fig. 27.—Hand after removal of Metacarpal Bones and three Fingers, leaving Thumb and Little Finger.

The mortality after amputation of the fingers and metacarpal bones is very trifling. Should death unfortunately occur after such a slight operation, it would probably be by the accidental occurrence of some general disease, such as erysipelas, pyæmia, or tetanus, to which every wound renders a patient liable.

An excellent stump may in some cases be obtained by amputating between the carpus and metacarpus. All the movements of the wrist-joint remaining perfect, a very useful artificial hand can be easily applied.

Amputation at the Wrist is not very often required. In performing disarticulation at this joint, its peculiar shape, with the convexity looking upwards, must be borne in mind. The operation may be performed in two ways, the chief flap being cut either from the dorsal or palmar surface. In the first case it is performed by *Teale's method* (Fig. 28). A perfectly square flap, whose four sides are equal in length to half the circumference of the limb at the level of the wrist-joint, is raised from the back of the hand. It must consist of skin and fat only, the extensor tendons being left on the hand. A short palmar flap, also composed of skin and fat only, and equal in length to one-quarter of the dorsal flap, is now raised. The extensor tendons may now be divided at the level of the wrist, and the joint opened and disarticulated. Lastly, both flaps being held well back, the flexor tendons are smoothly divided with a single sweep of the knife. The flaps must be brought accurately together in the way directed on p. 66, Fig. 11. By this method the dorsal flap is somewhat long and thin, and is consequently liable to slough unless it be very carefully raised, care being taken not to turn

the edge of the knife to the flap, but to keep it constantly directed towards the parts to be removed.

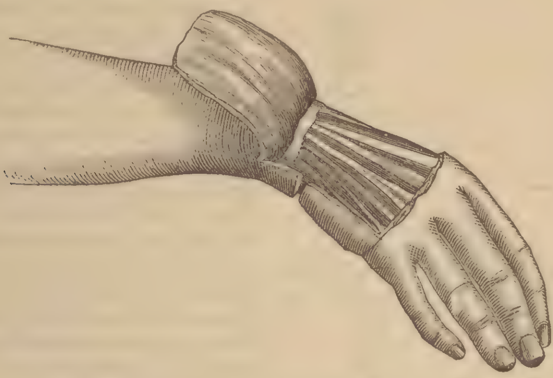


Fig. 28.—Amputation of the Wrist by Teale's Method.

In amputation by the *long palmar flap*, the operation has been performed, either by cutting the flap from within outwards after opening the wrist-joint, or by shaping the flap from the palm first and disarticulating afterwards. The former method is objectionable, as the prominence of the pisiform bone and the hook of the unciform on the inner side render its performance extremely difficult. In the latter method (Fig. 29) a large flap, almost square in shape, but having its angles rounded off, is marked out in the palm by an incision, commencing at one styloid process and terminating at the other. The flap should extend as far as the transverse fold in the palm opposite the heads of the metacarpal bones. The flap having been thus marked out, it is carefully raised from the palm, and is made to include everything down to the flexor tendons. When the palmar flap has been raised to the level of the wrist joint, a curved incision, with its convexity slightly downwards, is made, so as to connect the two extremities of the previous incision. The joint is now opened, and the ligaments divided. The hand is attached now only by the flexor tendons, which may be divided by a single sweep of the knife—the palmar flap being carefully held out of the way. The palmar flap will be found usually to contain the median and ulnar nerves and the superficial palmar arch, with portions of the muscles of the thumb and little finger. It is better to cut the two nerves short, in order to prevent their implication in the cicatrix.

Fig. 29.—Amputation at the Wrist by Long Palmar Flap.

AMPUTATION OF THE ARM.—**Amputation of the Forearm** is not unfrequently required for disease or injury of the wrist or hand. In performing this operation, as long a stump should be left as possible, so as to give the patient more power over any artificial limb that may be fitted to it. The flaps should be about a couple of inches in length, and well rounded, the hand being placed in a mid state between pronation and supination. The dorsal flap is best made by cutting from without inwards; the line of incision commences just at the palmar aspect of the ulna, is carried forward for a little distance parallel to this bone, and then across the back of the arm in a slightly curved manner, until it reaches the palmar aspect of the radius; it then passes along this until it reaches a point opposite to that at which it commenced, and the flap thus made is dissected back. The palmar flap is next made by transfixion (Fig. 30). As soon as it is cut, the bones are cleared by a couple of sweeps of the knife, and the interosseous membrane is divided; the bones are then sawn together. The vessels are cut long at the end and on each side of the palmar flap.

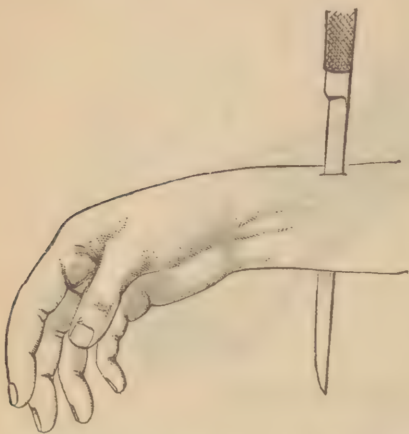


Fig. 30.—Amputation of the Fore-arm. Transfixion of the Anterior Flap.

When the palmar flap is formed by transfixion in amputation of the fore-arm, considerable inconvenience is often caused by the protrusion of the mass of tendons and muscles included in it. To avoid this, both flaps may be made by cutting from without inwards. It is advisable to make the dorsal flap a little longer than the palmar, so that the line of

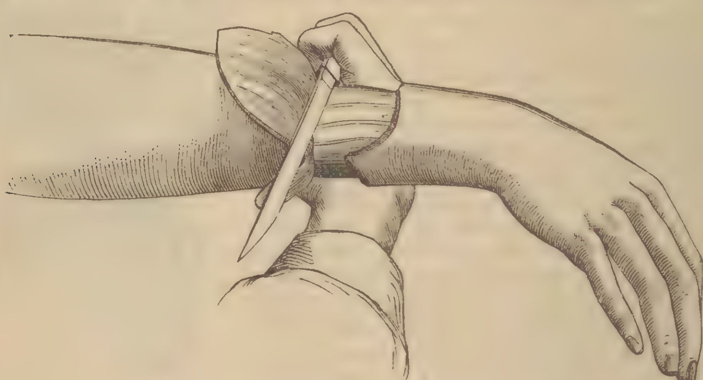


Fig. 31.—Amputation of the Fore-arm by Skin Flaps.

the cicatrix may fall well away from the ends of the bones. The operation may be thus performed (Fig. 31). The Surgeon, standing so as to take the flaps in his left hand, and holding the arm with its dorsal surface upwards, enters the knife at the palmar edge of the bone furthest

from him. He then marks out a flap from the dorsal surface, equal in length to two-thirds of the anterior-posterior diameter of the limb at the point where it is intended to saw the bones. The flap must be sufficiently broad, and rounded at its corners. After raising this, taking only the skin and fat, a flap similar in shape, but half the length, may be raised from the palmar surface in the same way. The knife is now firmly swept round the bones at the level of the angle of the flaps (Fig. 31), so as to divide the muscles circularly at this point. The soft parts are now to be retracted from the bones by a process of careful dissection, for a distance of from three-quarters of an inch to one inch, and the bones cleaned and sawn at this point. The result is, that the bones are buried in the muscles, and over all lie the light skin flaps, free from any tension or tendency to displacement. There will be a dependent opening for the exit of discharges, and, when healed, the cicatrix will be well to the palmar aspect of the bones, and consequently free from pressure. It may be found, in retracting the muscles from the bones, that the anterior interosseous artery has been cut in more than one place. This may cause some trouble in securing it. Great care should therefore be taken to avoid the accident, by keeping the edge of the knife constantly turned towards the part to be removed. If the median and ulnar nerves are seen to be cut somewhat long, they should be pulled out with forceps, and cut short, so as to avoid if possible their implication in the cicatrix near the end of the bone.

Amputation of the arm is most readily performed by lateral flaps, made by transfixion from before backwards; the bone is then well cleared

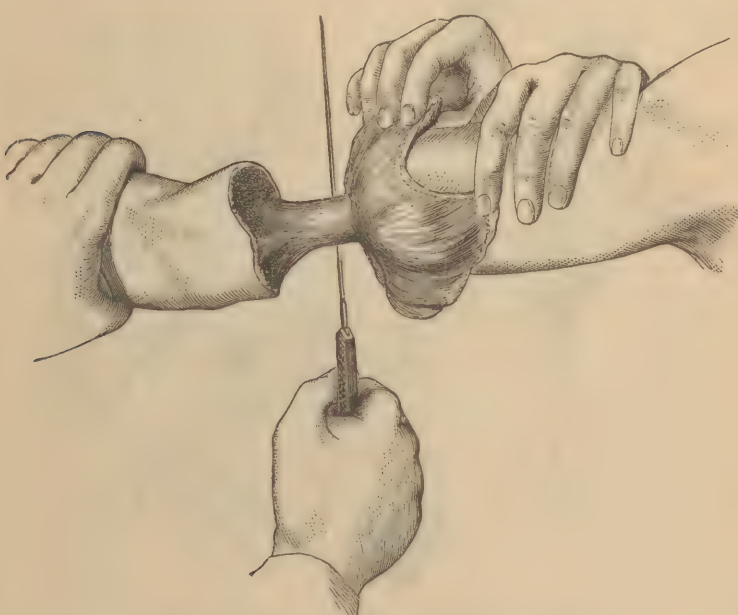


Fig. 32.—Amputation of the Arm. Clearing the bone.

by a couple of sweeps of the knife, and sawn across. In clearing the bone, care must be taken fairly to divide the musculo-spiral nerve by a firm sweep of the knife round the back of the bone (Fig. 32), if the ampu-

tation be performed in that part of the arm where this nerve winds round the humerus. If the limb be very muscular, skin flaps and circular section of the muscles will probably give the best result.

Amputation at the shoulder-joint may be required for injury of the arm or for disease of the humerus; in the first case it is best performed by *transfixion;* in the other, by *cutting from without inwards.* Hæmorrhage during the operation may be prevented effectually by compressing the subclavian artery as it passes over the first rib; though, if the assistant be steady and well acquainted with his duties, this even may be dispensed with.

The precautions above described for preventing loss of blood during the operation, are quite sufficient in most cases. But if the Surgeon have no assistants on whom he can rely, Esmarch's India-rubber compressor may be applied. After bandaging the limb with an elastic bandage, a large pad should be put in the hollow above the clavicle so as to press on the subclavian artery. The compressor is then passed under the axilla and crossed once over the shoulder, and its two ends pulled on strongly by two assistants. It is difficult to keep it in place after disarticulation, but this is possible if it be put on sufficiently high up, so as to embrace the scapula.

In operation by *transfixion*, a long narrow-bladed knife should be used. One assistant must have charge of the limb; another should raise the flap; and a third must follow the knife as it cuts behind the humerus, and grasp the inner flap with the axillary artery, so as to prevent hæmor-

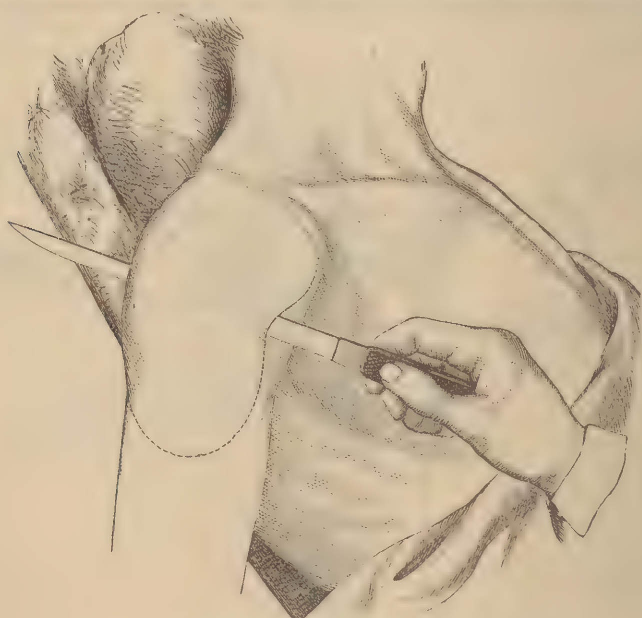


Fig 33.—Amputation at the Shoulder-joint by Transfixion.

rhage from this vessel. An assistant holding the arm away from the body, so as to relax the deltoid somewhat, the knife, instead of being entered by a puncture, should make a small cross-cut, about an inch in extent, at the point at which transfixion is to be made, so as to prevent

that jagging of the integuments by the heel of the instrument which would otherwise occur. If the operation be on the *right* side, the Surgeon stands before the patient, and the point of the knife should be entered about an inch in front of the acromion, or midway between the acromion and the coracoid process (Fig. 33); and being carried directly across the joint and capsule, should pass out at the posterior border of the axilla. If on the *left* side, the Surgeon stands behind, and the point of the knife must be entered well behind the spine of the scapula, at the posterior border of the axilla, carried across the anterior aspect of the joint, and brought out to the outer side of the coracoid process. In either case, the large flap containing the deltoid muscle must then be cut by a sweep of the knife downwards, and, as soon as made, raised by the assistant. The heel of the knife is now to be laid on the head of the bone, the capsule of the joint cut across, and the attachments of the muscles to the tuberosity divided. In order to facilitate this part of the operation, it is generally recommended that the arm should be carried forcibly inwards across the chest. This may readily be done in the dissecting-room, or in actual practice where the limb is removed for disease of the humerus, the bone being entire; but in the case of comminuted fracture of the humerus, with extensive laceration of soft parts, it is useless to attempt this manœuvre. In cases of this kind, the head and upper end of the humerus being broken off from the shaft, the lever-like action of the bone cannot be put in force, and it is sometimes not such an easy

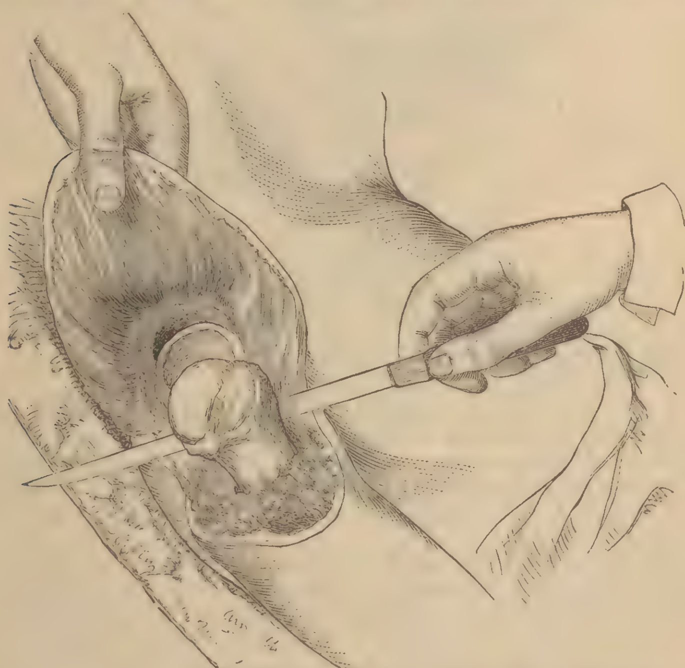


Fig. 34.—Amputation at the Shoulder-joint. Opening the Capsule, and making Inner Flap.

matter as might at first appear, to detach its head from the glenoid cavity. In order to do this, I have in cases of comminuted fracture of the humerus, in which I was amputating at the shoulder-joint, found it necessary,

after opening the capsule, to seize hold of the upper fragment and to draw it forcibly downwards and outwards by inserting the fingers between the head and the glenoid cavity, in order to divide the muscles inserted into it. After the head of the bone has been turned out of the glenoid cavity, the knife must be passed behind it, and carried down for a distance of about three inches close to the bone at its inner side (Fig. 34). The Surgeon then cuts across the soft parts, so as to form the inner flap. In doing this, the assistant, to whom this part is entrusted, must follow the knife with his hands, grasping firmly the whole thickness of the inner flap, so as to compress the axillary artery, and thus prevent the occurrence of hemorrhage (Fig. 35). The Surgeon should not cut

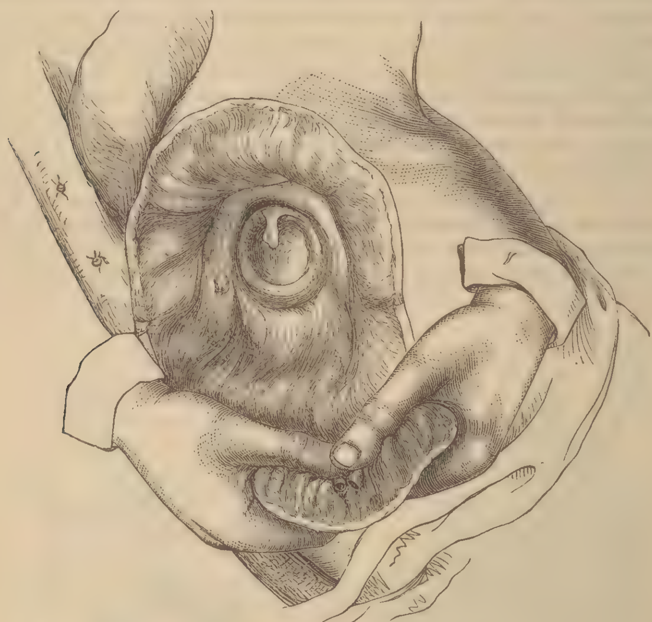


Fig. 35.—Amputation at the Shoulder-joint. Holding Vessels in the Inner Flap.

the flap across until the assistant tells him that he holds the vessel firmly, and then he must be cautious not to injure his assistant's fingers. The artery will be found to be cut long in the middle of the inner flap, and a few smaller branches may be required to be tied at its inner angle, and in the deltoid. The stump after it is healed will present the appearance shown in Fig. 36.

Amputation at Shoulder by Oval Method.—In cases in which, from the state of the bone, the manipulations necessary for amputation by transfixion are impossible, the method originally invented by Larrey, or some modification of it, must be adopted. Larrey commenced his operation by a vertical incision down to the bone, about two inches in length, commencing immediately below the acromion process. From the end of this he made a curved incision on each side, reaching to the corresponding fold of the axilla. The two flaps thus formed were dissected up, and the head of the bone disarticulated. The knife was then passed internally to the head of the bone, and carried downwards, while

an assistant followed it with his hands to compress the axillary artery. The operation was completed by dividing the tissues in the axilla, between the ends of the two curved incisions previously made to its borders.

Fig. 36.—Stump after Amputation at the Shoulder-joint.

The most important modification of this method is that of Spence, which is specially adapted for gun-shot wounds of the upper end of the humerus. It consists in carrying the vertical incision further forwards, and commencing it just externally to and below the tip of the coracoid process, as in excision of the shoulder-joint. The incision ought to expose the tendon of the long head of the biceps lying parallel to it and at its bottom. This may be turned on one side, and the joint opened and examined; and if from the state of the parts it be still considered necessary to amputate, the operation is completed by making an oval incision through the skin from the end of the original cut, taking care not to go so deeply on the inner side as to wound the vessels. The outer flap is then dissected up, so as to enable the

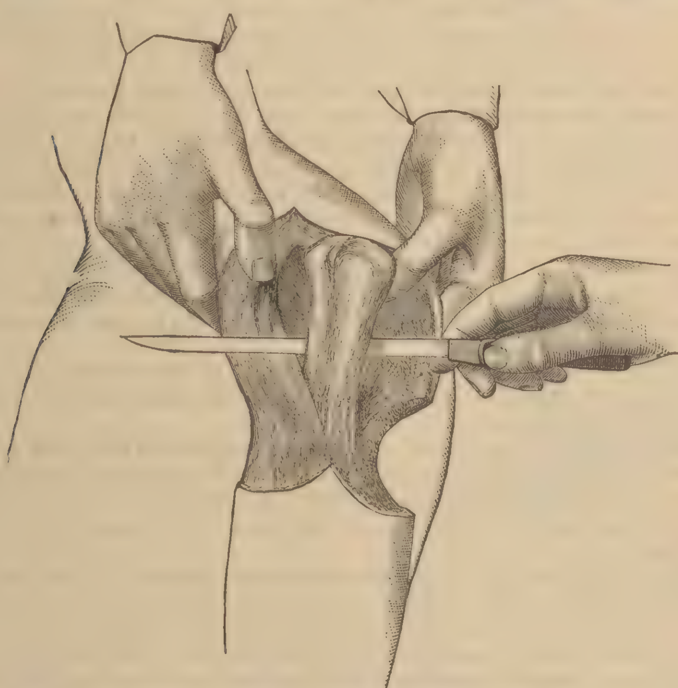


Fig. 37.—Amputation at Shoulder by Spence's Method.

surgeon to get his knife internal to the head of the bone, between it and the axillary artery (Fig. 37). The assistant follows the knife with

his hands, and grasps the vessels, and the operation is finished by dividing the tissues left uncut at the inner side.

In those cases in which this operation is performed for disease, especially for tumor of the humerus, by which the soft parts are thinned or condensed, it may very conveniently be done by making the anterior flap by dissecting it up from without inwards, using of course for this purpose a short knife; a broad bistoury is most convenient. The joint is then opened, and the posterior flap formed in the usual way. In this way I have easily performed amputation at the shoulder-joint for large tumors of the head of the humerus.

General Results of Amputations of the Upper Limb.—Amputations of the upper extremity, even for injury, are extremely successful. In the Crimea, amputations of the fore-arm were fatal in the ratio of 5, and those of the arm of 24·5 per cent. The table at p. 80, in the last chapter, gives a mortality of 34·4 per cent. for traumatic amputations of the upper arm, and of 10·5 per cent. for amputation of the fore-arm. At Guy's Hospital, Bryant states that traumatic amputations of the fore-arm were fatal in the ratio of 16, and those of the upper arm of 22 per cent. At University College, in Liston's and my practice, of 12 traumatic amputations of the upper arm, there were 5 deaths; whilst of 8 in which the fore-arm was removed, all recovered. The cause of death is usually pyæmia, erysipelas, or congestive pneumonia.

Amputations of the fore-arm and arm for disease, more particularly for strumous affections of the bones and joints, are very successful operations. When they are done for malignant disease, the risk is greater. In the table already referred to, the mortality after amputation of the arm for disease is 26 per cent., and of the fore-arm 15·9 per cent.

Amputation at the shoulder-joint for injury, although necessarily more fatal, is very successful for so severe a procedure. In 46 recorded cases in civil practice, there were 26 deaths, or 56·5 per cent., while of 607 cases in military surgery, 294, or 48·4 per cent., died. In the French army in the Crimea, of 222 cases, 137 died, or 61·7 per cent.; while in the English army during the same war, the mortality was only 35 per cent., and in the war of the American rebellion, it was 39·2 per cent. At University College Hospital, I have done the operation six times with one fatal result. When this operation proves fatal, the patient usually sinks from exhaustion, or is carried off by the extension of erysipelas or gangrene to the stump and trunk.

Amputation at the shoulder-joint for disease of the humerus is a very successful procedure, considering the size of the part removed, and its proximity to the trunk.

AMPUTATIONS OF THE FOOT.—The **Phalanges of the Toes** seldom require amputation; when they do, they may be removed in the same way as the corresponding parts of the hand—by the formation of a flap on the plantar surface, either by cutting from above downwards, or by transfixion.

In removing a bone at the **Metatarso-phalangeal Articulation,** the oval method should always be practised, so that the sole of the foot may not be cut into. In doing this it must be remembered that the articulation is situated considerable above the web of the toes, and the incision must therefore be commenced proportionately far backwards (Fig. 38). As a general rule, it will be found that the articulation is about the same distance above the web as the point of the toe is below it.

The **Metatarsal Bone of the Great Toe** occasionally requires removal in whole or in part. The whole of the bone may be readily removed by one or two methods: 1, by the flap; 2, by an oval amputation.

1. The *Flap Amputation* is done as follows. The point of a strong broad bistoury is entered on the dorsum of the foot over the interspace between the first and second metatarsal bones, as far back as possible;

Fig. 38.—Incision and Position of Joint in Amputation of a Toe.

it is then carried forwards upon the ball of the great toe, to a point opposite to the web between the toes, and thence made to sink into the sole of the foot in a line parallel to the outer margin of the bone; the flap thus formed is dissected back, its plantar aspect being kept as thick and fleshy as possible (Fig. 39). The Surgeon next passes the knife between the first and second metatarsal bones, and cuts directly forwards through the centre of the angle between the great and the second toes. In doing this, care must be taken that the edge of the knife is not directed too much towards the metatarsal bone of the great toe, lest it hitch against one of the sesamoid bones. The Surgeon next seizes the extremity of the toe, and, pulling it well inwards, passes the point of the bistoury deeply into the angle of the wound (Fig. 39), where, by the division of some tendinous and ligamentous fibres that constitute the key of the joint, he opens the articulation, and detaches the bone by lightly touching its ligamentous attachments. By keeping the edge of the knife well against the side of the bone, he may avoid wounding the dorsal artery of the foot, the bleeding from which would be troublesome. When the bone is to be partially removed, the operation must be performed in the same way; the incisions, however, not being carried so far backwards.

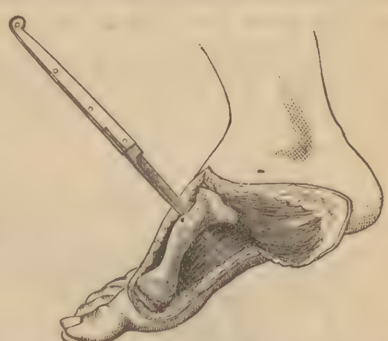


Fig. 39.—Removal of Metatarsal Bone of Great Toe: Flap formed: Joint being opened.

2. In *Amputation by the Oval Method*, the point of the bistoury is entered in the dorsum of the foot, just behind the tarsal end of the bone. An incision is carried up to the digital interspace, and is made to circle round the base of the first phalanx, so as to join the first line of incision on the dorsum (Fig. 40). The soft structures on the inner side are then

Fig. 40.—Amputation of the Great Toe by Oval Method.

dissected down, the knife being kept close to the bone. The same process is carried on at the outer side, the blade made to sweep under the bone from without inward, and the tarsal joint opened as described in the flap operation.

This process has the advantage of leaving the sole uninjured. It has the disadvantage of favoring an accumulation of sanies and pus at the deeper part of the wound.

3. If the disease be limited to the anterior part, the shaft of the bone should be cut across with a pair of bone nippers, and its base left; for, as this gives insertion to the peroneus longus, its removal will materially weaken the foot.

The **Metatarsal Bone of the Little Toe** may conveniently be removed by an oval incision, so as to avoid wounding the sole of the foot. This is best done by entering the point of the knife just behind the tubercle of the bone, carrying it forwards and inwards in the line of its articulation with the cuboid, to the centre of the fourth digital interspace, and thence forwards to the web of the toe; the knife is next carried round the plantar surface of this, the incision being continued obliquely into that which has been made on the dorsum of the foot (Fig. 41). The small flap thus formed is well dissected down, the knife passed round the under surface of the bone, and the joint opened by the toe being forcibly drawn outwards, and its ligamentous connections lightly divided.

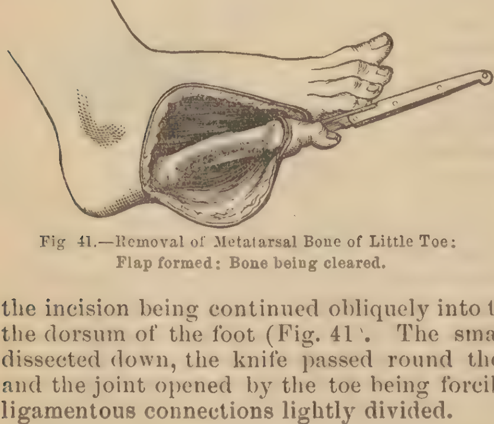


Fig. 41.—Removal of Metatarsal Bone of Little Toe: Flap formed: Bone being cleared.

The middle metatarsal bones, when diseased, do not admit of separate removal so as to leave a foot that would be useful to the patient.

Amputation of the Metatarsus.—When the metatarsus and anterior part of the foot are extensively diseased or injured so as to require removal, the amputation may be effected by one of two methods; viz., 1. By making a flap from the sole and a transverse incision across the dorsum, and then sawing across the metatarsus as a whole above the seat of injury or disease; or, 2. By disarticulating the metatarsus from the tarsus.

The first operation—that of sawing through the metatarsus—is usually called Lisfranc's; but in reality it was practised and described by Hey long before Lisfranc's time.

By "Hey's Amputation" is usually meant the disarticulation of the metatarsus from the tarsus, and the formation of a flap from the anterior part of the sole of the foot. But Hey describes three different amputations, only one of which corresponds to this method. In his "Practical Observations, London, 1814," p. 550, he says, "I have judged it to be the safer method to take away all the diseased integuments by a transverse and a longitudinal incision made at right angles to each other, and then to saw off the metatarsal bones as far as the morbid integuments extended."

At p. 553 he says, that in operating on a girl about 18, a method suggested itself to him "of finishing the operation, which proved highly advantageous to the patient. Having dissected out the metatarsal bones and removed the toes by a transverse incision made at their junction with the metatarsal bones, I elevated the integuments and muscles forming the sole of the foot, &c." This operation was done in the year 1797.

In the year 1799, p. 554, he states that he operated as follows: "I removed all the toes at their junction, with the metatarsal bones, and then separated the integuments and muscles, forming the sole of the foot, from the inferior part of the metatarsal bones, keeping the edge of my scalpel as near the bones as I could. . . . . I then separated with the scalpel the four smaller metatarsal bones at their junction with the tarsus, which was easily effected, as the joints lie in a straight line across the foot. The projecting part of the first cuneiform bone which supports the great toe, I was obliged to divide with a saw."

Thus it would appear that in the first case Hey *sawed across* the metatarsal bones after having made the flap. In the second case, he *dissected out* all the metatarsal bones, and then made a flap from the sole. In the third case, he first made the sole flap, and then, having *dissected out* the four smaller metatarsal bones, *sawed* across the internal cuneiform; thus combining the two methods of cutting and sawing.

The *whole of the Metatarsal Bones* may then be removed from the tarsal by the operation originally planned and executed by Hey. This consists in first of all making a large convex flap in the sole of the foot, one horn of which commences at the tubercle of the fifth metatarsal bone, whilst the other terminates at that of the first, or rather one inch in front of the tubercle of the scaphoid. A small flap is then made on the dorsum of the foot, and the articulations are exposed. These must then be opened with some care, as they are very irregular (Fig. 42); the second metatarsal bone, especially, being sunk into a kind of pit between the inner and outer cuneiform bones, and the articulation of the fifth with the cuboid being very oblique. This operation is seldom practised, disease being rarely limited to the metatarsal bones, but usually

implicating the joints as well. Their disarticulation also from the tarsus is very troublesome, on account of the irregularity of the line of articulation; hence it is better to saw through the metatarsus just in front of the tarsal articulations, than to attempt to disjoint the bones.

Fig. 42.—Line of Hey's Operation.

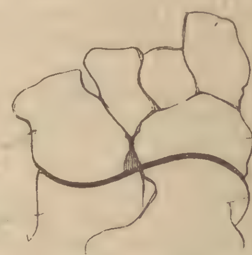


Fig. 43.—Line of Chopart's Operation.

A combination of these two procedures may sometimes be advantageously adopted. In several of those severe crushes of the anterior part of the foot, that are not unfrequently the result of tram or railway injury, and in which the bones and soft parts are irregularly crushed and torn, I have made a very excellent stump by disarticulating the first and the fifth metatarsal bones, and sawing across the three middle ones almost an inch interior to their articulations with the tarsus, or by simply dissecting back the sole of the foot, clearing the bones, and sawing them across at a convenient line.

Fig 44.—Chopart's Operation. Flap formed before Disarticulation.

Amputation through the tarsus may conveniently be performed by Chopart's operation, which consists in disarticulation in the line between the os calcis and astragalus behind, and the cuboid and scaphoid in front (Fig. 43). This operation may be performed in two ways, either by first making the flap from the sole of the foot, and then disarticulating (Fig. 44); or, the joints having been cut through from the dorsum, the flap may afterwards be made (Fig. 45). I prefer the first plan, as it enables the Surgeon to make a more correctly fashioned flap.

In operating on the *left* foot, the knife, a stout bistoury, should be entered well behind the tubercle of the scaphoid, and carried forwards for at least three inches, to about the head of the metatarsal bone of the great toe, then right across the sole, and down the outer side of the foot, as far as half an inch behind the metatarsal bone. On the *right* foot this

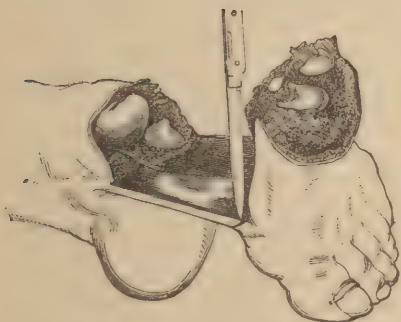


Fig. 45.—Chopart's Operation. Flap formed after Disarticulation.

Fig. 46.
1. Line of Amputation of Great Toe.
2. Line of Chopart's Operation.
3. Line of Excision of Os Calcis.

line of incision is reversed, by the knife being entered half an inch behind the metatarsal bone of the little toe, carried forwards to the root of the toes across the sole, and down the inner side to behind the tubercle of the scaphoid (Fig. 46, 2). This flap should be made long, especially at the inner side, but well rounded at the angles, and should consist of the whole thickness of parts in the sole of the foot, which must be well dissected out from the concavity under the metatarsal bones. But in children and young adults, in whom the foot is often long and the tarsus thin, the flap need not be made so long. A convex incision is then made along the dorsum from one horn to the other of the plantar flap; the parts are well retracted, and the articulations opened by the Surgeon bearing firmly upon the anterior part of the foot, and lightly touching the ligamentous structures with the point of his bistoury. In this stage of the operation, care must be taken that the edge of the bistoury be not inclined too much backwards, lest it slip over the astragalus and open the ankle-joint; or too far forwards, lest it pass anterior to the scaphoid—between it and the cuneiform bones. After disarticulation has been produced, the projecting head of the astragalus and the articular surface of the os calcis should be sawn off. In more than one instance, I have found firm osseous ankylosis existing in the line of articulations, so as to require the use of the saw for the separation of the anterior part of the foot. When this complication occurs, the tarsus should be treated as a whole, and sawn through, irrespective of articulations, behind the limits of the disease. The result of this operation is extremely favorable, the patient, by the aid of a properly constructed boot, being able to walk, and even dance,

with very little appearance of lameness. In some cases, where the muscles of the calf are very strong, and the calcaneum projects, the heel becomes drawn up, and the end of the stump made to point down in such a way that the patient is rendered lame by walking on the anterior sharp edge of the calcaneum, which irritates the flap. This condition is best removed by division of the tendo Achillis.

Disarticulation of the Foot at the Ankle-joint was first reduced by Syme to a regular operation. By its performance amputation of the leg may often be avoided, the patient being left with an exceedingly useful stump, which, as its covering is ingeniously taken from the heel, constitutes an excellent basis of support. Syme's words as to the direction of the incision are: "The foot being held at a right angle to the leg, the point of the knife is introduced immediately below the malleolar projection of the fibula, rather nearer its posterior than anterior edge, and then carried across the bone, slightly inclining backwards, to the inner side of the ankle, where it terminates at the point *exactly opposite* its commencement" (that is, a little below and behind the internal malleolus). "The extremities of the incision thus formed are then joined by another passing in front of the joint. The operator next proceeds to detach the flap from the bone" (Fig. 47). The object of carrying the incision so far back is, that the dissection of the flap may commence from the most prominent point of the plantar surface of the os calcis, that is to say, from the anterior part of the two tuberosities of that bone. Every eighth of an inch in front of this point increases the difficulty of raising the flap. The lateral ligaments should be touched with the point of the bistoury, and the tendo Achillis divided by pressing the foot forcibly downwards and cutting from before backwards. By twisting and dissecting at the same time the os calcis is completely separated from its soft attachments, and the foot removed (Fig. 48); the two malleoli must then be sawn off (Fig. 50), the arteries tied, and the flap brought up. A well-formed rounded stump will thus be left.

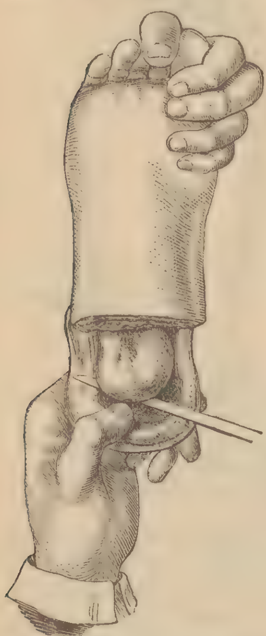


Fig. 47.—Syme's Amputation of the Foot. Clearing the Os Calcis.

In performing this operation, care must be taken that no button-hole apertures be made through the posterior part of the heel flap. This may commonly be avoided readily enough when the soft structures in this situation are greatly thickened and infiltrated by plastic matter, as the result of chronic disease; but, if the operation be required for injury of the foot, great care is required in digging out the heel, the integuments at the posterior part of the os calcis being very thin and adherent to the bone. It is also of importance that the incision across the heel should be carried well back over its point (Fig. 49). Unless this be done, a large cup-shaped flap will be left, in which blood and pus will accumulate, and the cicatrization of the stump will be much retarded. As union takes place by granulation, there will be a tendency to bagging in the stump; but this may be prevented by proper bandaging. The

tendency to sloughing and to undue suppuration chiefly occurs in those cases in which the amputation has been performed as a primary operation for a crush of the foot. In one case in which I had occasion to perform it for an injury of this kind, a good deal of trouble resulted from this cause, though eventually the case did perfectly well, and the patient now walks with scarcely any difficulty. It has been frequently stated that it is necessary, in order to ensure the vitality of the flap, to cut the posterior tibial artery "as long as possible," and it is this as much as anything that has led to the production of the huge cup-shaped flaps which are so difficult to dissect off the os calcis and which so often slough. A careful examination of the vascular supply of the flap will show at once that the posterior tibial artery may be cut close to the base of the flap, without in the least interfering with the chief vessels supplying it. The distribution of vessels to the part is as follows. On the outer side, the peroneal artery, after giving off the anterior peroneal, is continued down along the posterior aspect of the fibula to the outer side of the os calcis. On the inner side a branch of considerable size arises from the posterior tibial artery, about one-and-a-half to two inches above the ankle-joint, and passes down to the inner side of the os calcis, running behind the inner malleolus and accompanying the small cutaneous nerve from the posterior tibial to the skin of the heel. There is thus a main trunk on each side running down to the heel behind the malleolus, and these two communicate freely with each other superficially over the cutaneous surface of the tendo Achillis, and deeply between the tendon and the back of the ankle-joint; and they terminate by anastomosing again by long vascular loops on the under surface of the posterior part of the os calcis. It is upon these anastomosing loops that the vitality of the flap depends more than upon anything else; and as they lie much nearer the bone than the skin it is evident that, unless the knife be kept hard upon the bone during the whole dissection of the flap, they will be divided in large numbers, greatly endangering its vitality. In the operation as performed by Syme, the dissection of the flap is commenced from the most prominent part of the tuberosities of the os calcis, and the knife can be kept in constant contact with the bone with the greatest ease. If, on the contrary, the flap extend far into the sole of the foot in front of the tuberosities of the os calcis, it is almost impossible to dissect it back without the point of the knife being directed into the under surface of the flap

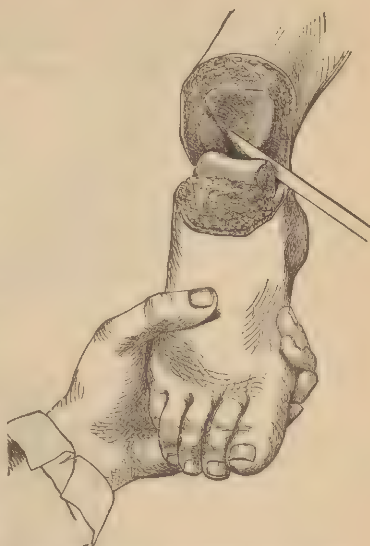


Fig. 48.—Syme's Amputation of the Foot. Anterior Incision and Disarticulation.

Fig. 49.—Syme's Disarticulation at Ankle-joint.

and the vascular loops being divided. All the above-mentioned vessels can be readily dissected out in any well injected foot in the dissecting-room.

This operation is a most useful one in all cases requiring removal of the whole foot. The mortality attending it is but small. I have never known a fatal case. The stump that is left admits of good pressure being exercised directly upon it, without tenderness or fear of ulceration.

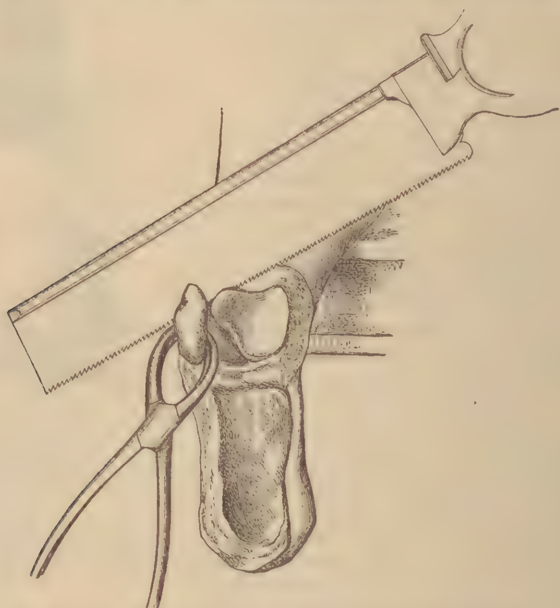


Fig. 50.—Syme's Amputation of the Foot. Sawing off the Malleoli.

Various modifications of Syme's amputation may at times be practised with advantage, in consequence of the soft parts covering the heel being more or less ulcerated or disorganized, so as not to admit of forming a good basis of support. In these circumstances, the flaps may be fashioned from the sides instead of from behind; and in this way I have more than once formed an excellent covering to the end of the stump. These lateral flaps should not, however, be made in any case that admits of disarticulation at the ankle in the ordinary way. They never afford so good a basis of support as the integuments of the heel, which are far more dense and elastic.

Pirogoff's Amputation is characterized by the preservation of the posterior portion of the os calcis. The operation is performed in the following way. An incision is carried across the sole of the foot from the tip of the external malleolus to the corresponding point on the other side. This incision should not be made directly transverse to the foot, but should incline forwards obliquely, so that the centre of the incision in the sole may be at least one inch and a half in front of a line drawn transversely from the tip of one malleolus to the other (Fig. 51). It should reach, in fact, a little beyond the anterior extremity of the os calcis. The knife should be then sunk in well down to the bones in the direction of the incision, care being taken in crossing the sole of the foot that the knife is not carried directly down to the bones, but is slanted

obliquely backwards. Disarticulation of the astragalus is then effected in the usual way, by an incision across the front of the foot. The foot

Fig. 51.—Line of Incision for Pirogoff's Operation—modified by Oblique Section of the Os Calcis.

is now forcibly extended to the greatest possible extent, and a common saw is applied immediately behind the astragalus, and the bone cut

Fig. 52.—Pirogoff's Operation. Sawing the Os Calcis obliquely, downwards and forwards.

obliquely downwards and forwards, so that the saw should come out immediately behind the articulation of the os calcis with the cuboid (Fig. 52); the malleoli are then removed, and a thin slice of the tibia

with the articular cartilage taken off (Fig. 53). The opposed osseous surfaces must then be accurately adjusted, the movable flap well supported by a broad strip of plaster, and the limb laid on the outer side, with the knee placed so as to take off the tension of the tendo Achillis. The advantages of the long oblique section of the os calvis over the shorter almost vertical cut originally made by Pirogoff are, as Busk has pointed out, that a larger surface of bone is brought into contact with the sawn ends of the bones of the leg, that the remaining piece of bone does not require to be tilted so much on its own axis, and that consequently the tendo Achillis is not put so much on the stretch, and that the thick skin of the heel, naturally in contact with the ground, still serves as the basis of support instead of the thin skin of the back of the heel, which is turned downwards in the other method. The advantages of this operation over the ordinary mode of disarticulation consist in the stump being longer, to the extent of the thickness of the portion of the os calcis left in it, and being better adapted for pressure (Fig. 54); in the readiness of the union of the two applied osseous surfaces; and in the less likelihood of the supply of blood to the posterior flap being interrupted, as its vascular communications are not much disturbed. These advantages are not, however, always real, and are in some degree counterbalanced by the liability to recurrence of disease in the portion of the os calcis left in those cases in which the amputation is done for disease. When it is practised for injury, however, this objection does not hold good. Another objection which has been raised against this operation, consists in the supposition that the section of two osseous surfaces exposes the patient to increased risk of osteophlebitis and pyæmia. In the first case in which I performed this amputation the patient, a healthy lad, whose foot was removed for injury, died from this cause. But subsequent and extended experience has convinced me that there is no special liability to pyæmia after Pirogoff's amputation. After its performance, patients can run; which they can not do after amputation of the leg in any part.

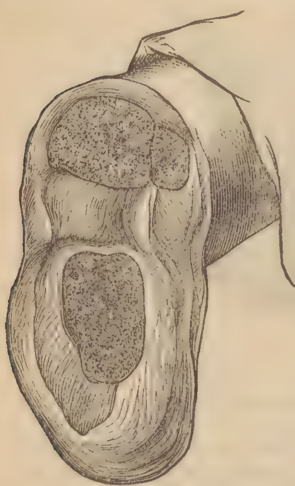


Fig. 53.—Pirogoff's Amputation. Appearance of Parts after Removal of Malleoli..

Fig. 54.—Stump after Pirogoff's Amputation.

The **Subastragaloid Amputation** is another mode of disarticulating the foot. In it the heel-flap is made as in Syme's operation, and, the articulation between the astragalus and scaphoid being opened (the ankle-joint left intact), the bistoury is passed under the astragalus, between it and the calcaneum, which together with the rest of the foot is removed. In this amputation a good, long, useful stump results; but the cases requiring it must be few, as it does not often happen that there is disease of the calcaneum together with the anterior range of tarsal bones, without the astragalus also being involved.

In cases of caries of the tarsus requiring amputation, it occasionally happens that the Surgeon cannot determine with certainty whether the morbid action is limited to the anterior range of tarsal bones, or extends so far backwards as seriously to implicate the astragalus and calcaneum; and he is consequently unable to decide whether the condition of the foot admits of removal by Chopart's operation, or requires disarticulation at the ankle-joint. In these circumstances all doubt will be cleared, and the proper operation performed, by making an incision across the dorsum of the foot in the line of the astragalo-scaphoid and calcaneo-cuboid articulations; these are then opened, and the state of the bones is examined. If the astragalus and calcaneum be sound, or but slightly diseased on their anterior aspect, Chopart's operation may be done, and any carious bone left behind gouged away. If, on the contrary, these bones be found to be deeply implicated, the flap may be dissected back for about an inch, and disarticulation at the ankle-joint proceeded with. It may also be well to bear in mind that the tarsal articulations may have become so ankylosed, as the result of old disease, as to require the application of the saw, instead of opening the joints by the knife.

Results.—The amputation of a toe, of a metatarsal bone, or even of a portion of the metatarsus, is but very seldom attended by fatal consequences. Should death occur, it must be the result of an accidental attack of tetanus, erysipelas, or of pyæmia. Disarticulation at the ankle-joint, though necessarily somewhat more dangerous, is yet one of the most successful operations in Surgery, the mortality attending it being but very small.

Amputation of the Leg may be performed in three situations: either just below the knee, in the middle, or in the lower third of the limb. The selection of the line of amputation must depend in a great degree upon the extent of the disease or injury, but, whenever practicable, the operation should be performed low down; the mortality diminishing in proportion as the limb is removed near to the ankle. Of 106 amputations in this situation done in Paris, there were only 13 deaths. Surgeons used formerly, even where the disease or injury was limited to the foot, to amputate immediately below the knee, in all those cases in which the patient would be obliged to wear a common wooden pin, the long leg-stump being highly inconvenient when the patient rested on his bent knee; whereas, in those individuals who could afford the expense of a well-constructed artificial limb, the amputation, when practicable, was done in the lower part of the leg. But this difficulty has been removed by the introduction of a short wooden pin, in the socket of which the stump may be fixed in the extended position; and amputation in all admissible cases should consequently, even amongst the poorer classes, be done just below the calf, at the junction of the lower and middle thirds of the limb; nearer the ankle than this, it is not easy to get a good covering for the bones.

The number of arteries divided will depend upon the situation of the amputation. Holden lays down as a general rule in amputations one inch below the head of the fibula, one main artery only—the popliteal—is divided. At two inches two arteries, the anterior and posterior tibial, are cut. At three inches three arteries, the peroneal, in addition to the two tibials, being divided.

Flap Amputation of the Leg may be performed in the following way. The tourniquet having been applied to the artery in the popliteal space, the assistant, whose duty it is to retract the flap, takes his stand in this, as in all amputations of the lower extremities, opposite to the

Surgeon. In the *left* limb, the point of the knife is entered at the posterior edge of the tibia, carried forwards for a distance of one inch and a half to two inches, then across the anterior part of the leg to the posterior border of the fibula, up which the incision is made to extend to a corresponding distance. In the *right* leg the same incision commences on the fibular side of the limb, and terminates on the tibial. The flap thus formed, which should be broad and well rounded, is next dissected up by a few touches of the point of the knife, and transfixion of the limb is made by passing the blade across behind the bones, from one angle of the incision to the other (Fig. 55). The posterior flap is then formed by

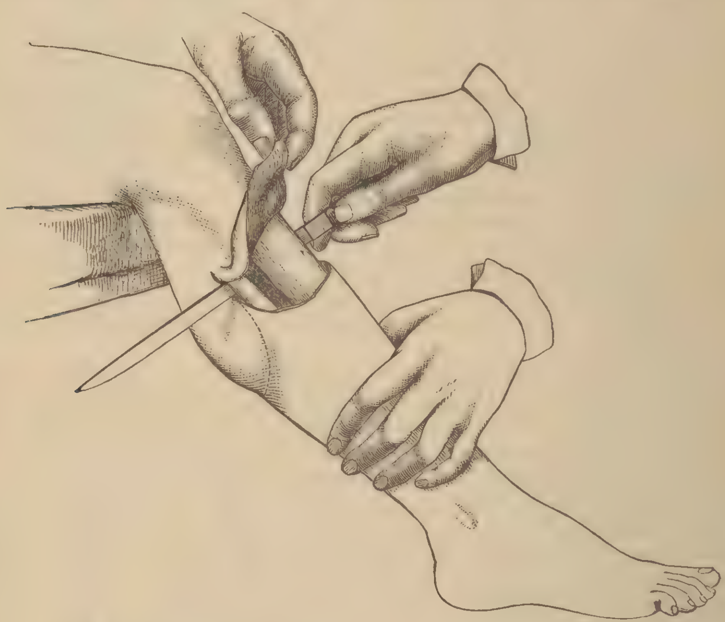


Fig. 55.—Amputation of the Right Leg. Transfixion of the Posterior Flap.

cutting obliquely downwards and backwards, and should be about three inches long. The bones are next cleared by a double sweep of the knife, and the interosseous soft parts divided by carrying the instrument in a figure-of-8 way between the bones. In doing this, especial care must be taken not to direct the edge upwards, so as to split either of the tibial arteries, more particularly the anterior: for, as this vessel retracts above the membrane, its ligature, when divided too high, is no easy matter. If the amputation be performed just below the knee, it is possible that the popliteal trunk may be divided before its bifurcation, and thus one artery only require the ligature. In sawing the bones, the fibula should always be cut first, as otherwise it will be nearly sure to be splintered. This bone may be best divided on the left side, by sinking the hand below the level of the limb, and using the heel of the saw; and on the right, by holding the hand above the limb and cutting with the end of the instrument (Fig. 56). After the removal of the limb, the sharp anterior edge of the tibia may advantageously be sliced off obliquely, so as to lessen the risk of sloughing of the corresponding flap from pressure upon a sharp ridge of bone.

If the limb be very muscular, a large pad of the muscles of the calf will be left in the posterior flap; this will usually be a good deal in the

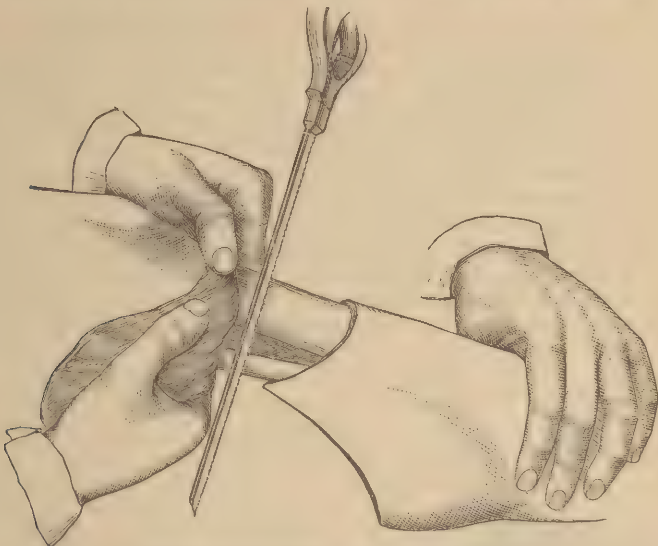


Fig. 56.—Amputation in the Leg. Sawing the Bones.

way during treatment; it may slough and thus interfere with proper union. In some cases, I have advantageously removed at one sweep

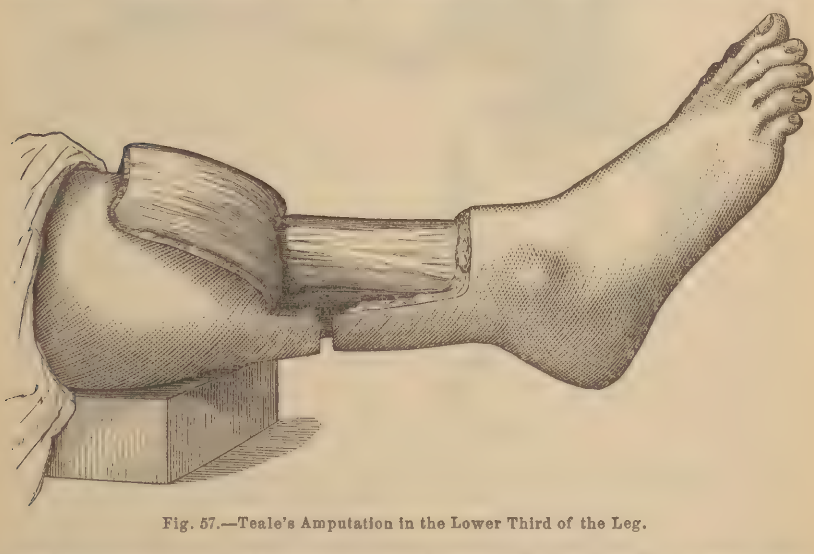


Fig. 57.—Teale's Amputation in the Lower Third of the Leg.

the greater part of the muscular mass thus left, leaving little more than a skin-flap. In order to avoid redundance of muscle, the best operation consists in forming skin-flaps on the anterior and posterior aspects of the limb, and then making a circular cut through the muscles. This may be done in various ways, according to the seat of the amputation and the amount of skin available for the formation of flaps.

In cases of injury immediately above the ankle, **Teale's operation** (Fig. 57, also Figs. 10 and 11, p. 66) can be readily performed, according to the rules laid down on p. 66. If the soft parts be retracted from the bones for a distance of from an inch to an inch and a half or two inches above the angle of the flaps, all the advantages of Teale's method can be obtained by making an anterior flap equal in length to the diameter of the limb almost rectangular in shape, but having the angles rounded off. A very short posterior flap may be cut to meet this by carrying the knife behind the limb somewhat obliquely from one end of the first incision to the other. The soft parts are then retracted and the bone sawn as high as possible. As in Teale's method, the flap should contain all that can be taken from the bones, as in this situation they are somewhat liable to slough. Lister recommends that the incision should be carried, on the fibular side, as high as the point at which the bone is to be sawn, as this greatly facilitates the separation of the soft parts. In order to avoid unnecessary wounding of the anterior tibial artery, Teale

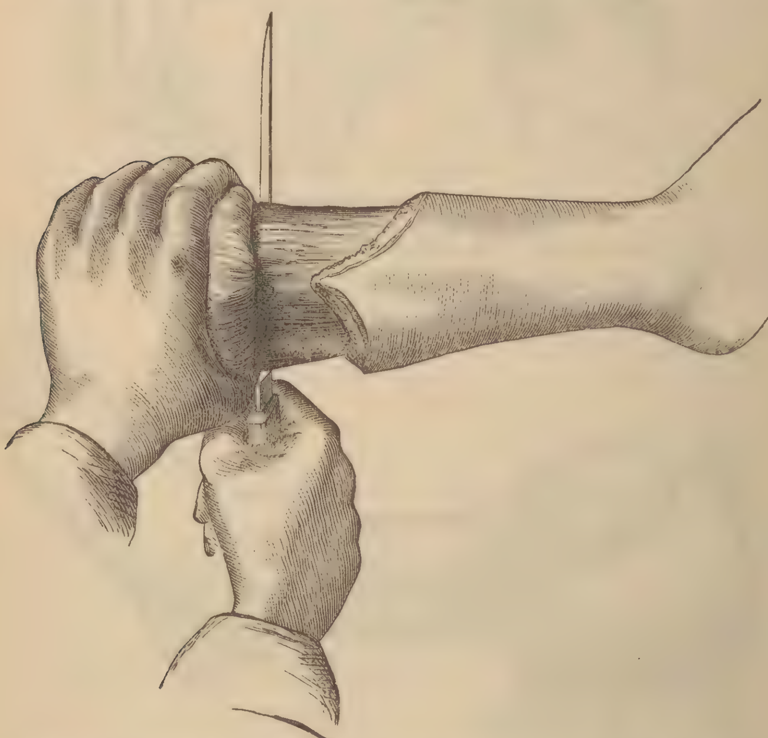


Fig. 58.—Amputation of the Leg by Long Anterior and Short Posterior Skin flaps, with Circular Division of the Muscles.

recommends that the soft parts should be raised from the interosseous membrane of the finger or thumb nail. In the middle and upper thirds of the leg, the bones lie more towards the anterior aspect of the limb, and consequently it is not necessary to provide so long an anterior flap in order that the cicatrix may be placed well behind them. In these situations the anterior flap may be made equal in length to two-thirds

of the diameter of the limb, and the posterior flap one-half the length of the anterior. The anterior flap should consist, at its lower edge, of skin and fat only, but it should be gradually deepened as it is raised, till at its base it contains almost all the muscle that can be obtained from the front of the limb (Fig. 58). In dissecting up the posterior flap, the limb should be raised so that the Surgeon can more conveniently see what he is doing. It should contain only skin and fat. Both flaps being held well out of the way, the muscles are now divided circularly, and the soft parts raised from the bones for a distance of from one and a half to two inches. In doing this, care must be taken not again to wound the anterior tibial artery. Finally, the bones are cleaned and sawn as high as possible. The sharp point of the tibia must be rounded off. In doing this it is well carefully to raise the periosteum with a knife or periosteal elevator before applying the saw or bone-forceps, as by so doing the tendency to necrosis is somewhat diminished, the periosteum not being torn away to a higher point than that at which the bone is actually sawn.

If from any cause there should not be sufficient skin available to form the long anterior flap, the **circular operation** or the modification of it recommended by Liston, as described on page 65, may be employed instead (see Fig. 9, p. 65). All these operations have the great advantage of getting rid of the heavy mass of the muscles of the calf, and that by the long anterior flap secures in addition that the cicatrix shall be well behind the cut ends of the bones, and that there shall be a dependent opening for the exit of the discharges. The long anterior flap tends to keep itself in position by its own weight, and no strapping is required as in the amputation by the long posterior flap, and so a great source of pain to the patient and disturbance to the stump is avoided. The tendency to protrusion of the bone is also much less, as the weight of the flap is hardly sufficient to cause ulceration, if the end of the tibia has been carefully rounded.

Results.—Amputation of the leg is, upon the whole, a successful operation. The mortality, however, varies not only according to the situation at which the limb is removed, but also according as it is done for injury or disease, and the nature of that disease. So far as situation is concerned, it may be stated, as a general rule, that the nearer the knee the greater is the danger.

In amputation of the leg for injury, the rate of mortality is, upon the whole, rather high. In the Crimea, 37 per cent. of the cases were lost. The table at p. 80 shows an average mortality in civil practice of 46·1 per cent.; the death-rate, however, varies greatly in the records of different hospitals. Thus, at the Edinburgh and Glasgow Infirmaries, and Guy's Hospital, in an aggregate of 224 cases, there were 116 deaths; while in 353 cases in country hospitals, the number of deaths was 99, and in 66 cases at St. Bartholomew's Hospital, there were 20 deaths. At University College Hospital, the mortality has been 31·8 per cent. Secondary amputation is more fatal than primary; deaths from the former, according to the table at p. 82, being 48, and from the latter, 43·9 per cent. After amputation of the leg for disease, the mortality is much smaller; amounting, on a calculation based on 1281 cases, to 23·5 per cent. The chief causes of death are pyæmia, gangrene of the stump, and exhaustion.

Amputation through the Knee-joint, originally recommended in the last century by Hoin, and reintroduced by Velpeau, Markoe, and Brinton, has for some years found favor in this country and in America.

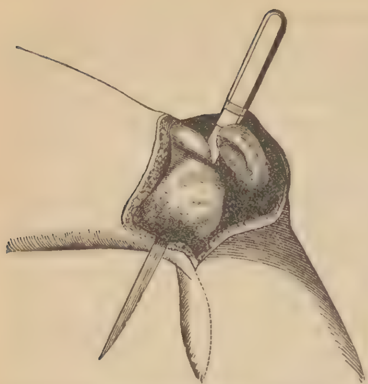


Fig. 59A.—Amputation through the Condyles by Long Posterior Flap.

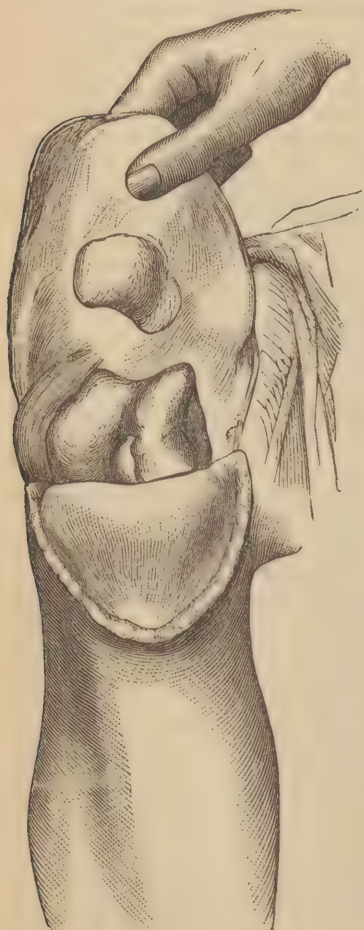


Fig. 59B.—Amputation through the Knee, by Long Anterior Flap.

Amputation through the knee-joint may be performed in three different ways: 1, with a long posterior and a short anterior flap; 2, with a long anterior and a short posterior flap; 3, by lateral flaps.

1. The operation with the **Long Posterior and Short Anterior Flap** may be readily performed in the following way. An incision is made directly across the knee-joint just below the patella. The skin-flap, thus formed is dissected back; and the joint being opened above the patella, and the ligaments divided by a few touches of the knife, a long posterior flap is cut from the upper part of the calf of the leg, by passing the knife behind the tibia, and carrying it downwards for a suitable distance (Fig. 59A).

2. The operation by means of a **Long Anterior and Short Posterior Flap** is thus performed. A long square flap, rounded at the corners, is made by entering the point of a short broad-bladed amputating-knife towards the posterior part of one condyle, carrying the incision downwards in a straight line for four or five inches, then across the limb, and cutting upwards to a point on the opposite side corresponding to that of entry. The integuments and the patella are then dissected from the front of the joint (Fig. 59). The articulation is thus opened; the ligaments are then successively divided, the limb being forcibly bent; and a posterior flap is formed by cutting with a determined sweep from behind forwards, or by dissecting down behind the bones and then cutting backwards. The flap should be about $2\frac{1}{3}$ to 3 inches long. If made shorter than this, it is apt to retract up the back of the thigh. Indeed, in all cases there is a great tendency to this, even when the flap is of the length above given. The popliteal artery is divided, and, with the exception of the articular vessels, is the only one requiring ligature.

The management of the patella is an important question; some Surgeons advocating its removal, and

others its preservation. I think that it is decidedly better to leave than to remove this bone. If left, it forms an important addition and protection to the end of the stump. If it be removed, not only are these advantages lost, but the flap becomes so thinned and weakened as to incur danger of gangrene. I have practised the operation both ways, and have from my experience found it most advantageous to leave the patella. There is only one objection to this; and that is the chance of the patella being drawn up, as occasionally happens, upon the anterior part of the thigh. This is best prevented by turning up the flap, and cutting across the tendinous insertion of the quadriceps extensor.

About the management of the cartilaginous surface of the femur in these amputations, there is a difference of practice. Some surgeons prefer leaving it; others, again, saw it off. If the articular surface be sound, the cartilage had better be left, as thus the cancellous structure is not opened, and one source of pyæmia is avoided. If the cartilages be eroded or otherwise diseased, they should be removed. This I generally do, after the disarticulation has been completed, by means of a fine-bladed Butcher's saw, cutting round and not across the end of the bone; thus not shortening the stump, but simply removing the cartilage, which would otherwise necrose or disintegrate, and thus interfere with ready union. If the cartilage be left on the femur, it should also be allowed to remain undisturbed on the patella. But if it be removed from the femur so as to expose the cancellous bone, then the inner sur-

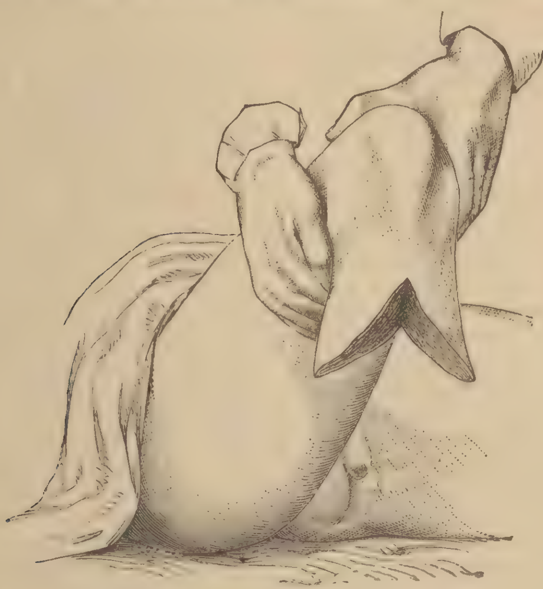


Fig. 60.—Amputation at Knee by Lateral Flap.

face of the patella should be removed in a similar manner, before the flap is laid down. This will be found to furnish an excellent covering to the bone; the patella, and the thick, tough, and extensile integuments of the knee, forming a good basis of support for the limb to bear upon, and one well adapted for pressure. The cut surface of the patella will apply itself to and unite with the cancellous surfaces of the condyles, and thus add to the solidity of the end of the stump.

3. S. Smith, of New York, amputates at the knee by **Lateral Flaps** in the following way. The incision is commenced about an inch below the tubercle of the tibia, and is carried downwards and forwards over the most prominent part of the side of the leg, until it reaches the under surface, where it is directed towards the median line. When this point is reached, it is carried directly upwards to the centre of the articulation. A second incision begins at the same point as the first, and pursues a similar direction on the opposite side of the limb; the two incisions meeting in the median line behind. The inner flap should be rather the larger, and the patella is left. After this amputation, the stump presents the appearance represented in Fig. 60.

Amputation through the Condyles may be done by a long posterior or a long anterior flap, including the patella or not; or by a modification of the circular method. Of these, that by the long posterior flap should never be employed, unless, from exceptional circumstances, no other flap can be obtained. Carden, of Worcester, was the first to employ the method of amputation by the long anterior flap in this situation. He took away the patella and made no posterior flap, but subsequent operators have found that without a posterior flap the covering is frequently insufficient. The operation is therefore usually performed as follows. The finger and thumb of the left hand are placed on the two condyloid eminences of the femur, which serve as guides for the starting points of the incision. A long anterior flap is then marked out, well rounded in shape, and reaching as low as the tuberosity of the tibia. This is dissected up either with or without the patella. In cases in which the Surgeon is hesitating between excision and amputation, the joint may be examined before proceeding further and the operation determined on. When the anterior flap has been raised, the knife is passed behind the femur, and a posterior flap, nearly equal in length to the anterior, is cut from within outwards. This flap contains the hamstring tendons, and usually a part of the muscles of the calf. It consequently retracts considerably after being cut. The flaps being held back, the knife is swept round immediately above the cartilage-covered surfaces, and the saw carried through the bases of the condyles parallel to the articular surface of the femur, that is to say, slightly obliquely to the axis of the shaft. Stokes, of Dublin, has recommended that the patella should be left in the flap, and its cartilaginous surface sawn off so as to form a raw bony surface, to be applied to the cut end of the femur. As a modification of these operations, Lister has recommended an amputation by a modified circular method, which is thus performed. "The Surgeon first cuts transversely across the front of the limb, from side to side, at the level of the anterior tuberosity of the tibia, and joins the horns of this incision by carrying the knife at an angle of forty-five degrees to the axis of the leg through the skin and fat. The limb being elevated, he dissects up the posterior skin flap, and then proceeds to raise the ring of integument as in a circular operation, taking due care to avoid scoring the subcutaneous tissue; and, dividing the hamstrings as soon as they are exposed, and bending the knee, he finds no difficulty in exposing the upper border of the patella. He then sinks the knife through the insertion of the quadriceps extensor (Fig 61), and, having cleared the bone immediately above the articular cartilage and holding the limb horizontally, he applies the saw vertically and at the same time transversely to the axis of the limb (not of the bone) so as to ensure a horizontal surface for the patient to rest on." When the soft parts are

much thickened, as in disease of the knee-joint, the patella may be raised in the flap and the leg removed by cutting the crucial and lateral ligaments. No great difficulty will then be found in exposing and sawing off the condyles of the femur. The advantage of this operation is that, if it be carefully performed, the chance of sloughing is reduced to a minimum. All these amputations require very careful drainage, as the pouches of the synovial membrane of the knee are very liable to fill with accumulations of serous fluid.

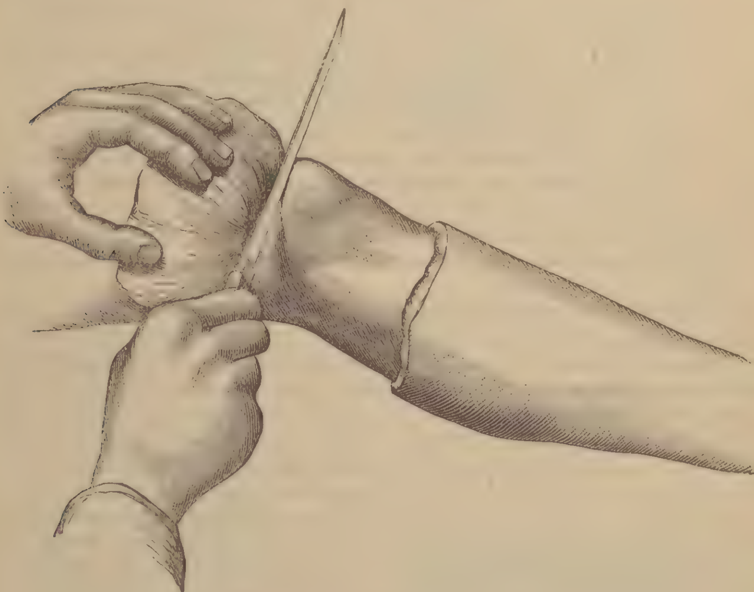


Fig. 61.—Amputation through the Condyles—a modified circular method.

The advantages of this operation over amputation of the thigh higher up are undoubtedly great. The limb being removed at a greater distance from the trunk, the shock to the system will be less, and the rate of mortality diminished; the medullary canal of the femur not being opened, there will be less likelihood of osteomyelitis; fewer ligatures will be required, and, if a long posterior flap have been made, these may be brought out through an opening made in the centre of it, as Blandin recommends; and lastly, a longer stump will be left, the movements of which will be more under the control of the patient than those of a shorter one, owing to the proper muscles of the femur not being divided, and all the movements of that bone being thus preserved in their integrity. There is a point of practice that I have found useful in this amputation; viz., to round off with the saw the sharp edge left on the condyle after the removal of its cartilaginous surface, as this otherwise may press injuriously upon the flap. In the after-treatment, the patella, if present, should be kept in its place by a strip of plaster well brought down above it; and care must be taken that a collection of pus do not form between it and the flat intercondyloid surface of the femur. This may be avoided by the insertion of a drainage tube at the time of the operation, and by subsequently syringing and carefully dressing the stump.

Results of Amputation through the Knee-joint or Condyles of the Femur.—So far as life is concerned, these operations have been successful. In the war of the American rebellion, of 132 cases, 64 died, giving a mortality of 48·4 per cent. Of these 49 were primary amputations; the deaths among which were 16, or 22·6 per cent. Brinton gives 62 cases of amputation through the knee for disease, with 14 deaths, or 32·6 per cent. The statistics of amputation through the condyles of the femur have not been made out.

These amputations present three great advantages over those higher up. 1. As the medullary canal of the femur is not opened, the patient is saved all that risk which results from suppuration within that canal, the infiltration of pus into it, and the consequent liability to suppurative inflammation of the veins of the bone, and consecutive pyæmia. 2. He is provided with a long thigh-stump, which gives increased leverage in using an artificial limb. 3. When the amputation is practised with the long anterior flap containing the patella, the end of the stump will be protected by the dense and tough integumental and aponeurotic structures naturally situated in front of the knee-joint, which admit of pressure being made upon them without fear of excoriation: the cicatrix being drawn up behind the end of the stump, and altogether away from its surface.

Amputations of the Thigh are commonly required both for accident and for disease. They may be performed in three situations: 1 immediately above the knee, 2 in the middle of the limb, 3 or in its upper third. Amputation just above the knee is best done by lateral flaps; for this reason, that the mass of muscle in this part of the thigh lies on each side of the limb, the central portion being occupied in front by the tendinous and aponeurotic structures connected with the patella, and behind by the upper triangle of the popliteal space: hence, if antero-posterior flaps be made here, they will be thin and tendinous in the middle; whereas the lateral flaps are uniformly thick and fleshy. In the middle and upper thirds of the thigh, the soft parts are so distributed that the antero-posterior flaps leave the best result, and give the best covering to the bone. If lateral flaps be made in these situations, the end of the bone is apt to be drawn up into the angle of the wound between the flaps, which fall away behind it. In amputation in the lower or middle third, a tourniquet may be applied high on the limb; but when the operation is done in the upper third, there is no space for the application of this instrument, and the Surgeon must then use the abdominal tourniquet or trust to an assistant compressing the artery as it passes over the brim of the pelvis (Fig. 5, p. 60). Compression is best made by grasping the great trochanter with the fingers of one hand, and then applying the thumb firmly over the artery; upon this the other thumb is then pressed as firmly as possible, and thus all chance of letting the vessel slip is prevented. In whatever situation the Surgeon amputates, he must be careful to carry the knife so as to cut clean and transversely, and not to split the femoral artery or vein.

Amputation above the Knee, or Vermale's Operation, is done by lateral flaps. In performing this operation, the outer flap should always be made first. The point of the knife, being entered in the middle of the thigh, about three inches above the upper border of the patella, is carried close round the bone and brought out through the centre of the ham: the flap is then cut downwards and outwards; the knife, being entered again in the upper angle of the incision, is carried close round the bone to its inner side, and the inner flap made by a sweeping cut (Fig.

62). Unless the blade be kept in contact with the bone in this situation, the femoral artery is very apt to be split. The flaps being then retracted, the bone is cleared by two sweeps of the knife, and sawn about four inches above its articular surface.

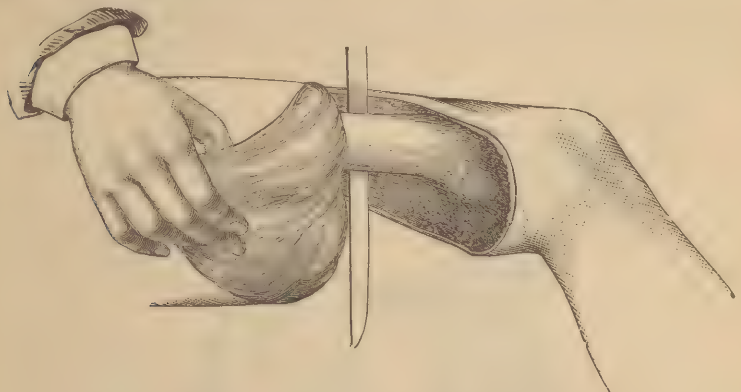


Fig. 62.—Amputation of the Lower Third of the Thigh by Lateral Flaps.

In the *Middle or Upper Third of the Thigh*, the **Antero-posterior Flap Operation** is to be preferred. In ordinary cases, the anterior flap may first be made, and the posterior one subsequently fashioned by transfixion (Fig. 63, see also Fig. 8, p. 63). If, however, the patient be very much emaciated, it is difficult to get a good cushion from the anterior part of the thigh in this way; and it is consequently preferable to follow the plan recommended by Mr. Luke of making the posterior flap first by transfixion, and the anterior one afterwards by cutting from without inwards (Fig. 64). In some instances in which the tissues at the posterior part of the thigh are much diseased or injured, whilst those on the anterior aspect of the limb are sound, a very good stump may be fashioned by making a long square anterior flap by transfixion, and then cutting at one stroke of the knife through the soft parts at the posterior aspect of the limb, in a somewhat oblique direction from below upwards. The anterior flap, when laid down, will form the cushion at the end of the stump.

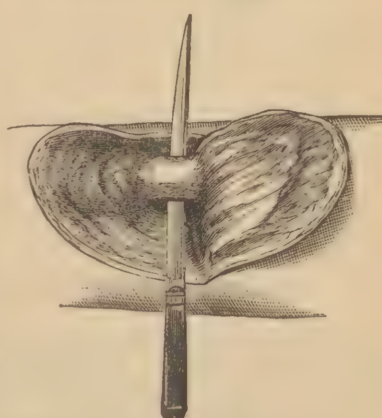


Fig. 63.—Amputation of the Thigh; Antero-Posterior Flap Operation.

If the patient be excessively muscular, the operation may be performed as follows. The Surgeon, standing on the right side of the patient, enters the knife midway between the anterior and posterior surface of the thigh on the side opposite to himself, and marks out a rectangular flap, with the right angles rounded off, equal in length to two-thirds of the diameter of the limb at the point at which the bone is to be sawn. He next sweeps the knife round the back of the thigh, so as to mark out

a rounded flap equal in length to half the anterior flap. The limb is now raised, and the posterior flap, consisting of skin and fat only, is dissected up to the angle of the flaps. The anterior is now raised, only skin and fat being taken for the first inch or so, after which the Surgeon takes as much muscle as he thinks advisable to ensure the vitality of the flap (Fig. 64). The remaining muscular tissue is now divided circularly, and the soft parts retracted for a distance of about two inches, and the bone

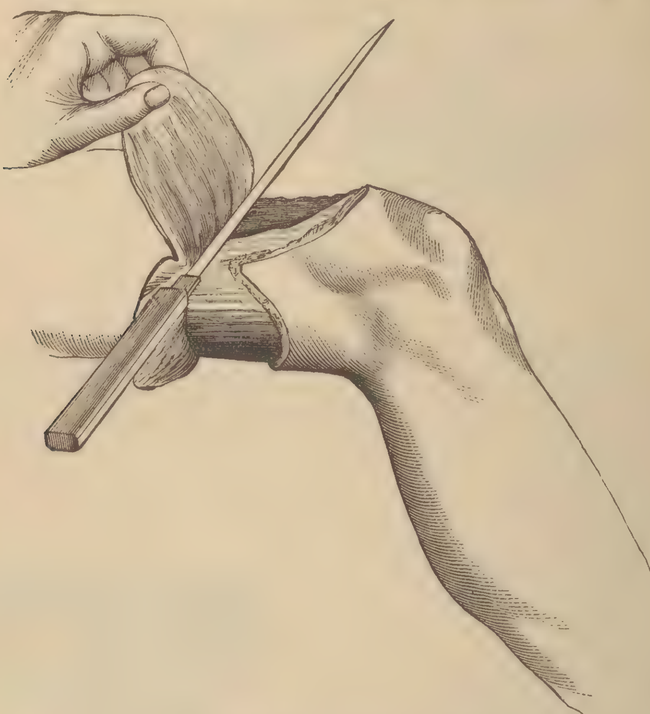


Fig. 64.—Amputation of the Thigh. Flaps cut from without inwards.

sawn at that point. The results of this operation are said by Lister to be most satisfactory. It may be performed equally well at any part of the thigh from the trochanters to the lower end, where the skin of the patella is included in the anterior flap.

Amputation through the Trochanters may sometimes be advantageously practised, either in severe compound fractures of the lower part of the thigh, or in cases of malignant, cartilaginous or osseous tumor of the lower and middle thirds of the femur; and thus the more severe and dangerous operation of disarticulation at the hip may be avoided. Indeed, should it be found, after section of the bone, that it is so much injured or diseased as to require removal at the joint, this may readily enough be done by dissecting the head out of the acetabulum with a strong scalpel or bistoury.

Results.—The mortality after amputation of the thigh is very considerable when the operation is done for injury, more particularly for compound fracture of the femur itself. The mortality after amputation for injury in civil hospitals amounts, according to the table at page 80,

to 59·7 per cent. In the French army in the Crimea, and in Italy, it was very high, amounting to 92 per cent. In some hospitals primary amputation of the thigh seems almost invariably to have been a fatal procedure; whilst in other institutions the mortality has not exceeded 50 or 60 per cent. At Guy's Hospital and at University College, secondary amputation of the thigh has been more fatal than the primary.

The result of amputation of the thigh for disease of the knee-joint depends entirely upon whether the affection is acute or chronic. In acute suppurative disorganisation of the knee, amputation of the thigh is most fatal; indeed, so high is the rate of mortality, that it is doubtful whether it is proper to perform the operation in that stage of the affection. In chronic knee-joint disease, on the other hand, the operation is most satisfactory and successful; death seldom resulting unless the operation has been deferred too long. The general percentage of mortality after amputation for disease is about 32·5.

The causes of death vary according to the condition for which the operation is performed. In primary traumatic amputation, the fatal event is chiefly brought about by exhaustion, traumatic gangrene of the stump, or secondary hæmorrhage. In secondary amputations, and in those for disease, pyæmia, erysipelas, and exhaustion are the usual causes of death.

Amputation at the Hip-Joint.—This formidable operation is of comparatively recent introduction into surgery. During the early part and middle of the past century, its practicability was warmly canvassed in France. It was performed on animals experimentally. It was found that patients affected with ergotism, whose lower extremities had become gangrenous, and had separated at the hip-joint, survived; and, at last, in the year 1773, the first successful amputation of the kind was performed by Perrault of St. Maure. In the next year, the operation was done in England by Kerr of Northampton, on a girl aged 12, affected with coxalgia and lumbar abscess. The operation was unjustifiable in such a case, but the patient lived 17 days, and thus its practicability was demonstrated. Larrey performed it in 1793 for the first time for gunshot injury; and since that time the operation has become an established one in surgical practice, civil as well as military. The operation was first performed successfully in England in 1812, by Brownrigg, of Plymouth, on a man whose thigh had been broken in the Peninsular war a year previously.

Amputation at the hip-joint may be and has been performed in a variety of ways, which it is not necessary to detail. The most convenient methods are those by *anterior-posterior* and by *lateral flaps*. Of these, that by **antero-posterior flap** is the simplest and speediest, and leaves the best stump. It consists in making a large and thick anterior flap by transfixion, and a short posterior one from the gluteal region and back part of the thigh. In order to perform this operation properly, the patient's body must be brought well forward upon the edge of the table, so that the nates project beyond it, and be steadied by strong bandages. One of these must be passed between the sound thigh and the perinæum, and attached to the upper end of the table; another should be carried across the pelvis to the lower end; and the sound limb must be tied to the leg of the table. The circulation through the limb should then be arrested by the application of Lister's compressor to the abdominal aorta (Fig. 65). This is a most invaluable instrument, completely restraining the circulation through the lower extremities, depriving this

operation of its great danger—undue loss of blood, and enabling the Surgeon to complete it without hurry or anxiety on this account. It should be applied a little above and to the left of the umbilicus. The Surgeon must have three assistants on whom he can fully rely. Assistant No. 1 takes charge of the flap, compressing the femoral vessels; and, in the absence of the abdominal compressor, on his trustworthiness the patient's life is mainly dependent. Assistant No. 2 takes charge of the limb; flexing it slightly on the abdomen in the first stage of the operation, whilst the anterior flap is being made; forcibly abducting and bending it backwards during the second stage, when the Surgeon is opening the capsule of the joint and making the posterior flap On the way in which he performs these duties, the facility with which the Surgeon performs the operation is mainly dependent. To Assistant No. 3 is consigned the care of the compressor of the abdominal aorta. After the removal of the limb, Assistant No. 2 aids the Surgeon in ligaturing the arteries. These preliminaries having been arranged, and the duty of each assistant assigned to, and distinctly understood by him, the operation is to be performed in the following way.

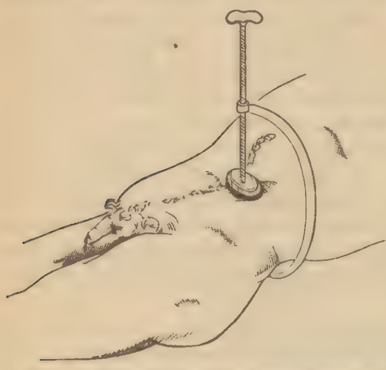


Fig 65.—Lister's Aorta Compressor applied.

The Surgeon, standing on the left side of the limb to be removed, feels for the bony points which guide his knife, viz., the tuber ischii and the

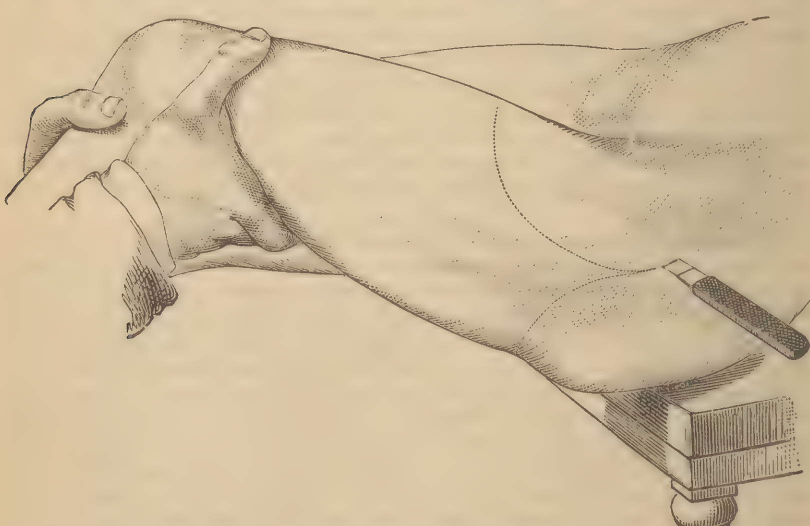


Fig. 66.—Amputation at the Hip-joint: Formation of Anterior Flap in Left Limb.

anterior superior spine of the ilium. The knife, which must have a blade twelve inches long, requires to be entered, and the flap to be made, in different ways, according to the side of the body on which the opera-

tion is performed. If it be on the *left* side, the knife should be entered about two fingers' breadth below the anterior superior spine of the ilium, or midway between it and the trochanter major, and carried deeply in the limb behind the vessels, directly across the joint; its point being made to issue just in front of the tuberosity of the ischium or immediately behind the prominent ridge formed by the tendon of the adductor longus (Fig. 66). In transfixing on this side, care must be taken not to wound the scrotum or the opposite thigh; the back of the knife must run parallel to, but not against the pelvis, and the point must not be held too high, lest it enter the obturator foramen. The anterior flap must then be rapidly cut downwards and forwards, about six inches in length. The limb, which has, during this stage of the operation, been raised and slightly flexed upon the abdomen, must now be forcibly abducted and everted; the capsule of the joint is then to be opened by a firm cut with the point of the knife. So soon as this is done, the head of the femur must be pushed up by forcibly depressing and abducting the limb, so that it may start out of the acetabulum (Fig. 68); the heel of the knife is then passed behind it, the remainder of the capsule cut across, and the posterior flap rapidly fashioned by carrying the knife downwards and backwards through the thick muscles in this situation. In doing this, the thigh should be extended and rotated inwards, so as to clear the trochanter. The posterior flap may be about four inches in

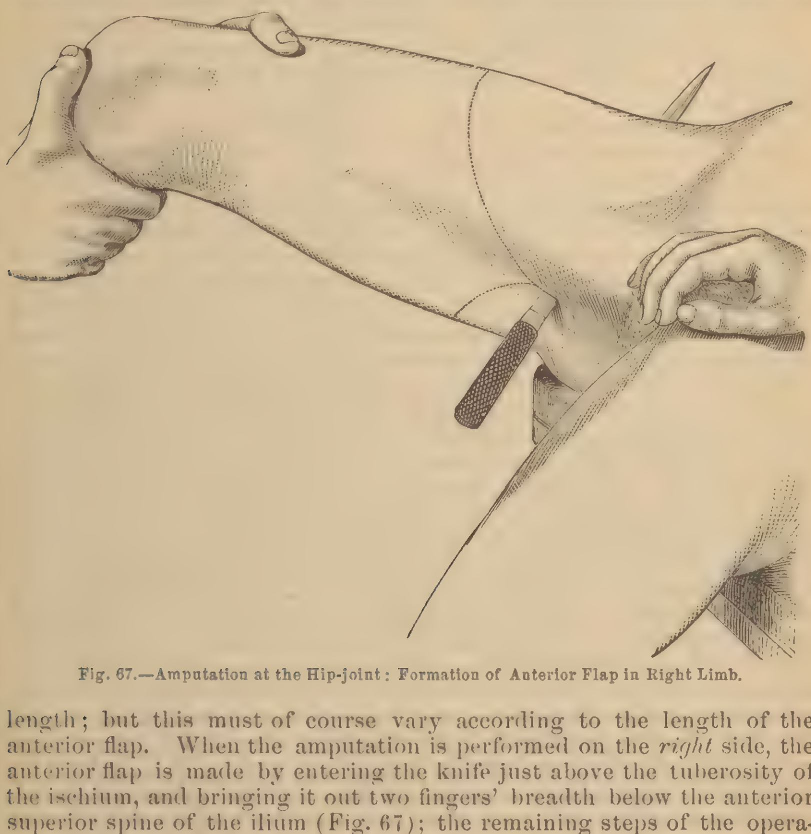


Fig. 67.—Amputation at the Hip-joint: Formation of Anterior Flap in Right Limb.

length; but this must of course vary according to the length of the anterior flap. When the amputation is performed on the *right* side, the anterior flap is made by entering the knife just above the tuberosity of the ischium, and bringing it out two fingers' breadth below the anterior superior spine of the ilium (Fig. 67); the remaining steps of the operation being performed as in the last case.

In consequence of the extent to which the limb that is about to be removed may have been injured, or have been encroached upon by disease, it is not always easy to make the anterior flap of the size or shape described. A little management on the part of the Surgeon will however enable him to take the requisite amount of covering from the outer or inner parts, by inclining the point or the heel of the knife downwards, as the case may require; or he may make the anterior flap by incision from without inwards, instead of by transfixion.

When the femur is entire and unbroken, Assistant No. 2 uses it as a lever, bringing the lower end of it in the second stage of the operation downwards and outwards, thus causing the head of the bone to press against the anterior part of the capsule, and to start out with a peculiar sucking noise as soon as that is opened. Should, however, the bone have been fractured high up, this movement cannot be given to it; and then the Surgeon must grasp the upper end of the femur below the trochanters, so as to steady and push it back as he is disarticulating its head. In two of the cases in which I have amputated at the hip-joint, it has been necessary to do this—in one, in consequence of the crush of the bone, two inches below the trochanters, by a railway accident; in the other, in consequence of its spontaneous fracture at the junction of its upper and middle thirds, in a case of rapidly growing malignant disease of the bone. This fractured condition of the femur necessarily makes the operation somewhat more difficult, as the Surgeon is deprived of the long lever afforded by the limb in its sound state, by which the head is tilted upwards and forwards, and the capsule put on the stretch so as to be brought directly against the point of the knife as it is drawn across it.

In amputation at the hip-joint, the great immediate danger to be apprehended is excessive hæmorrhage, the incisions being made so high up that no ordinary tourniquet can be applied. By means of Lister's compressor, the circulation through the abdominal aorta may be arrested, and thus the danger obviated. It is of great importance to perform the operation with as much rapidity as possible, and the disarticulation ought to be effected in at most thirty or forty seconds; and it may be done in much less time than this. The arrest of the hæmorrhage during the operation must be intrusted to an assistant who can be fully relied on. After the abdominal compressor has been applied, and the flow of blood through the aorta arrested, his business should be to compress the artery above the brim of the pelvis, and then to follow the knife in the first incision, and, as the anterior flap is being made, slip his fingers under it and grasp it firmly above and below, so as to compress the femoral artery in it, which is divided as the knife cuts its way out (Fig. 68). By grasping the flap tightly, there will be but little risk of hæmorrhage from the femoral artery, even when the abdominal aorta has not been compressed by the application of the tourniquet; but lest this should slip, or the assistant whose duty it is to grasp the flap by any chance should fail in holding it properly, it may be well to direct one of the assistants, whose business it is to steady the trunk, to have his thumb well pressed down into the iliac fossa, so as to compress the artery against the brim of the pelvis. As the posterior flap is being made, the bleeding from the gluteal and sciatic vessels, which is often very free, may be arrested by two assistants who should be ready to cover and compress them with the fingers or dry sponges. The arteries may then be ligatured one by one, as the assistant raises his fingers from them. If the other assistant have good hold of the femoral, the

vessels in the posterior flap may be tied first; but if the femoral be insecurely held, it must be first tied. The femoral arteries, both superficial and deep, will be found to be cut long, and to project from the muscles, by which they are surrounded, so as very readily to be seized

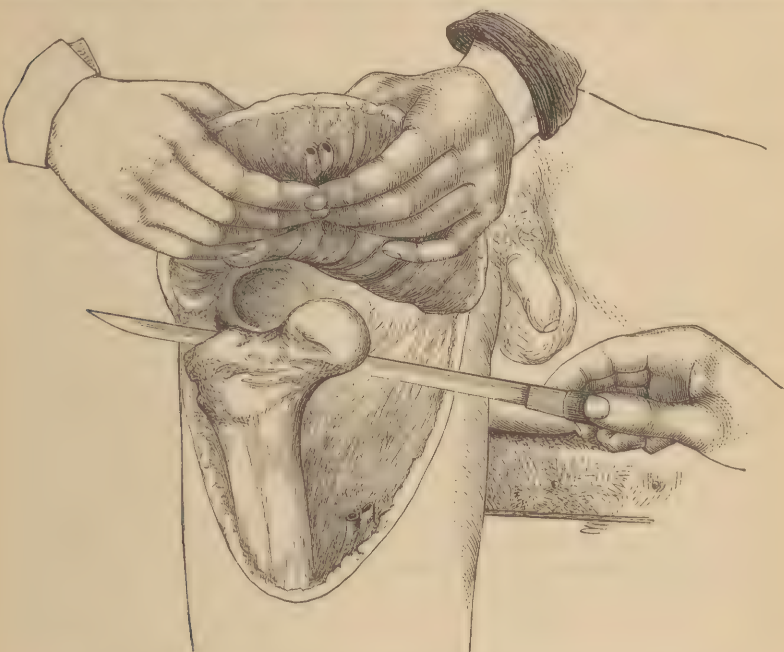


Fig. 68.—Amputation at Hip-joint; Compression of Femoral Artery in Anterior Flap.

by the fingers or forceps, pulled out, and ligatured. The arteries in the posterior flap and on the inner side of the joint will be found in the inter-muscular septa. The flaps are to be brought together by six or eight sutures, and a few long strips of plaster. The turn of a broad bandage may then be passed round the abdomen, and the end brought up from behind under the stump so as to support the flaps.

Results.—The mortality after amputation at the hip-joint is necessarily very high. This we should naturally expect from the size of the part removed and the consequent shock to the system. The rate of recovery varies greatly according to the condition of the limb that necessitates the operation. Thus, amputation at the hip-joint has been performed, so far as I can ascertain from published cases, 126 times up to the year 1864; of these 76 died. But in 47 instances it was for injury; of these 35 proved fatal; while in 42 cases in which it was done for chronic disease, 24 recovered and only 18 died.

Primary amputation at the hip-joint in cases of severe injury of the thigh, by gunshot or otherwise, with comminution of the femur, is one of the most fatal operations in surgery. In all the 12 cases in which it was done in the Crimea it proved fatal; and Legouest has collected 30 cases of this amputation for gunshot injury, in all of which the operation terminated in death. Indeed, up to the time of the war of the rebellion in America, there was no authentic instance of recovery under these circumstances. But in an elaborate and most able surgical history of

that great war, published by the Surgeon-General, 19 cases of primary amputation at the hip-joint for gunshot injury of the femur are related. Of these 11 died from the immediate shock of the operation; 5 died between the 2nd and the 10th day; one, a man 28 years of age, who had amputation at the hip performed by Surgeon Shippen seven hours after the receipt of his wound, was in perfect health four years after the operation; and the remaining two cases had been cured, so that one was alive and well two, and the other six months, after the amputation.

Intermediate operations, or those done during the inflammatory period, are very unsuccessful: 18 cases that occurred in the American war were all fatal.

Secondary amputation, in cases of attempted preservation of the limb after severe injuries and gunshot-wounds, has been far more successful. Four cases in which J. Roux practised it in the French campaign of 1859 in Italy all recovered, as did two out of nine in which it was practised in America.

Re-amputation at the hip-joint for diseased thigh-stumps has also been a successful operation: 4 out of 7 American cases recovered.

Amputation at the hip-joint for disease of the femur has undoubtedly become less fatal of late years than formerly. This is owing to the operation being submitted to at an earlier stage of the disease; to a better selection of cases; possibly to improved methods of after-treatment; but mainly to the influence of anæsthetics, by which the shock to the system necessarily resulting from so very severe a mutilation is materially lessened. The employment of Lister's aorta-compressor will probably still further reduce the mortality by lessening the loss of blood, and thus proportionately diminishing those risks of low secondary disease that are induced by serious hæmorrhage.

CHAPTER IV.

INFLAMMATION.

THE study of the inflammatory process is one of the most difficult on which the Surgeon can enter; but the labor required to master its details is well bestowed, inasmuch as an acquaintance with its nature, symptoms, and progress, gives an insight into a greater part of the Science of Surgery. The Management of Inflammation as it affects different tissues and organs, and as it in return is affected by various concomitant circumstances, comprises a great part of the duties of a Surgeon. The Theory of Inflammation is a purely physiological and pathological study; and, however interesting its investigation may be, yet, as the discussion of this subject belongs rather to the domain of General Pathology than to that of Practical Surgery, it cannot consistently be entered upon here otherwise than in mere outline. To gain a full acquaintance with the present state of our knowledge regarding the intimate nature, origin, and progress of the inflammatory process, the student must consult such books as the works of Sir James Paget and of Billroth on "Surgical Pathology," and the essays of Drs. Burdon Sanderson and Simon, and those observers in this country and abroad who have made inflammation the subject of special investigation.

Before describing inflammation, it will be necessary to notice briefly two forms of disturbance of the circulation which, while they always attend the inflammatory process, may exist independently of it. These are the two forms of local hyperæmia, known as **Congestion** and **Determination of Blood**: the former consisting essentially in retardation of the return of blood *from* a part: the latter, in increased flow of blood *to* a part.

CONGESTION plays an important part in Surgery: it occasions serious structural changes, and may run into inflammation. It is a true hyperæmia, an excess of blood. The blood in the affected part is not only greatly increased in quantity, but it circulates languidly and is of a darker color than natural. The arteries are, at most, of their normal size, perhaps even contracted; the veins and capillaries are greatly distended by the slowly moving fluid. When the circulation in the congested part becomes completely arrested, *stagnation* is said to occur.

Symptoms.—Congestion of an external part may be readily recognised by the changes it induces in the color, the size, the feel, the sensibility, the temperature, and the functions of the part. The color of a congested part ranges from purplish red to a dusky brown; its size is increased; it feels soft, and pits under the pressure of the finger. The patient is often conscious of a heavy, dull, aching sensation in it, scarcely amounting to pain, but yet attended with uneasiness. The temperature is never above, but often below, the natural standard, and the functions are lessened in activity.

The existence of congestion in an internal organ may be ascertained by finding its size increased, and its functions modified, with a sensation of weight in it. The symptoms of internal congestion are often, however, very obscure.

Effects.—These are of much surgical importance. The first change that usually takes place is an effort in the vessels of the part to relieve themselves, by a transudation of the more watery constituents of the blood into the surrounding areolar tissue. Hence the interspaces of this tissue are distended by the effused fluid, giving rise to *œdema*.

If the turgidity of the vessels be great, and their walls at the same time weakened, rupture will occur, and hæmorrhage to the surface, or into the substance of the part, will ensue.

In consequence of the infiltration of the areolar tissue, softening takes place, nutrition becomes less and less perfectly performed, and ulceration at last occurs. These changes we not unfrequently see in the integuments of the legs of old people. In other cases, the vessels becoming permanently dilated, the part assumes habitually a redder or darker tint, becomes swollen, and, if it be a mucous surface, it may be roughened and papillated, as is often observed in a congested conjunctiva.

Fibroid induration is not unfrequent in congestion of long duration, and is due to the gradual increase of the connective tissue around the distended blood-vessels. But although the affected part may be increased in bulk, the normal tissue is really atrophied by the presence of the new growth. The liver affords, perhaps, the best illustration of this process, in the *nutmeg atrophy* that is frequently found associated with obstructive disease of the heart.

Causes.—Congestion is always a passive and mechanical condition: and hence the term "active congestion" is not a proper one. What has been described as active congestion is merely a stage of inflammation.

The causes of congestion, always mechanical, may be divided into two great classes, which we often find conjoined: 1. Those causes that act by

obstructing the return of the venous blood; 2. Those that act by enfeebling the walls of the capillaries and veins, so that they are no longer able to withstand the outward pressure of the contained blood.

1. Amongst the first set of causes, may be specified any condition that directly and immediately interferes with the proper return of blood through a vein; in this way the pressure of a tumor upon such a vessel produces congestion of the part from which it carries off the blood.

Venous obstruction does not always act in so direct a manner as this; for it not unfrequently happens, that obstruction to the return of blood from one organ will be attended by a congestive condition of the vessels in a distant one. Thus we find some forms of congestion of the eye-ball connected with obstruction in the branches of the portal veins.

A long-continued dependent position of a part may occasion congestion, owing to the blood mechanically gravitating into it, and retarding, by the pressure thus brought to bear upon the vessels, the onward movement of the fluid within them. Thus we see congestion of the legs from long-continued standing; of the hæmorrhoidal veins from an habitually sendentary life; and of the posterior part of the lungs of those who have been long confined to the recumbent position.

2. Amongst the most common causes of congestion that act by enfeebling the vessels, we find the debility of old age, acting partly by lessening the tone of the vascular system generally, and partly by inducing a diminution of the propulsive power of the heart. So also cold, by lessening the vitality and retarding the circulation of a part, produces congestion in it. Certain typhoid or adynamic states of the system favor the occurrence of congestion in the more dependent parts. And, lastly, inflammation may terminate in this condition.

The obstructive causes are specially apt to induce congestion when they occur in connection with a feeble condition of the vascular system and with cardiac debility.

Treatment.—The treatment of congestion has strict reference to its cause.

The first indication consists in the removal of any source of obstruction to the return of blood from the part, as by unloosening a ligature, or elevating a part that has been too long dependent; or, less directly, as in the case of many internal congestions, by restoring the freedom of the circulation through the larger viscera. Thus, a congested eye or pile may be relieved by the removal of hepatic of portal obstruction.

The next indication consists in lessening the quantity of blood in the congested part. The mere removal of the obstructing cause may effect this. In other cases, the direct removal of the blood by scarification, as in a congested conjunctiva, or by leeches, as around a turgid pile, affords immediate relief. In some parts, again, the judicious application of a bandage will prevent or remove congestion. With this view, the hand and arm are bandaged before the apparatus for a fractured clavicle is applied: and in varix the leg is supported by an elastic stocking, to lessen the pressure of blood in the dilated veins.

The third indication in the treatment of congestion consists in constringing the dilated vessels by the direct application of an astringent to them; thus we habitually apply nitrate of silver to a congested mucous membrane, and cold douches to many external forms of the disease.

Determination.—We have already seen that congestion essentially consists in an impeded return of the venous blood from a part. In *determination*, the condition is reversed; arterial blood is sent in increased quantity to a part and circulates through it with great rapidity. This

condition, which is often called "increased action," differs, therefore, from congestion in every respect except in that of the blood being in excess.

Determination of blood is a vital process, often very transitory, and frequently occurs as a normal action in those conditions of the system in which, for temporary purposes, an increased afflux of blood is called for by particular organs. The enlargement of the mammæ before lactation, and the turgor of the erectile tissues, afford familiar illustrations.

An increased local supply of blood lies at the bottom of most surgical processes; few important surgical actions taking place without it. No process by which the separation of dead parts is effected, or by which the repair of wounds or ulcers is carried out, can occur without it. Every tissue is susceptible of it; and the Surgeon often excites it intentionally as one of the most efficient of his therapeutic means. Under these circumstances, therefore, it can scarcely be considered a disease.

When determination of blood becomes chronic or persistent, it may lead to such changes in the appearance, structure, and functions of a part as materially modify its nutritive and secretory activity; and then it becomes truly a disease. In these circumstances, the part is often said to be in a state of "chronic irritation."

Symptoms.—The symptoms of determination of blood are those that we should expect to result from an increased quantity of blood rushing with increased velocity through the affected textures. They are as follows:—Redness of a bright scarlet hue, swelling from turgescence of the vessels, heat appreciable to the Surgeon as well as to the patient, a feeling of fulness and of throbbing, with an increase in the quantity of the secretions of the part; in fact, all those symptoms that characterise inflammation in its milder forms, but in a minor degree and of a less persistent character.

Effects.—The effects of determination, when acute, consist either in rupture of the affected vessels, and a natural relief by the hæmorrhage which ensues, as may happen in piles after a dose of aloes has been given; or, if a free surface or a gland be affected, in the pouring forth of the secretions of the part, considerably augmented in quantity, and, perhaps, deviating somewhat from their normal character, as in lachrymation after the introduction of a grain of snuff into the eye. When this effusion occurs within shut serous sacs, dropsical accumulations may ensue.

The more remote effects of chronic determination of blood to a part consist in permanently increasing its nutritive activity, and thus leading to induration and hypertrophy. Or, determination of blood may run on to true inflammation.

Causes.—The causes of determination of blood are threefold.

First, an external irritant directly applied to a part will induce it, as when a grain of dust is blown upon the conjunctiva. Secondly, internal irritation, as excessive use of a part, will determine an increased flow of blood to it. Thus, using the eye much in microscopic investigations may produce redness, watering, and irritation of those organs. To this class of causes may also be referred the various forms of normal determination, such as erection, or the enlargement of the mammæ in pregnancy. Thirdly, there may be repercussion of blood from one part to another; as, when the application of cold to the surface produces an increased afflux of blood to an internal organ.

The vaso-motor influence of the sympathetic nerve exercises a marked control over the circulation of a part: and the relaxation of this control is attended by determination of blood. Thus, when the sympathetic nerve in the neck of a dog or rabbit is divided, the arteries in the corre-

sponding side of the head become dilated, a greater afflux of blood takes place, reddening of the skin and mucous surfaces occurs, and the temperature is increased—all these being evidences of the determination of blood to the affected side. Whether, and how far, an interference with the regulating power of the vaso-motor nerves has an influence in the causes of determination which have been noticed above, is a question of pathology beyond the scope of this book.

The *Treatment* of determination of blood is nearly identical with that of the milder forms of inflammation, of which we shall have to speak hereafter.

ACUTE INFLAMMATION.

The forms of local hyperæmia—Congestion and Determination—described above, are essentially characterised by an increase in the quantity of blood in the part. In congestion, the quantity of blood is increased, but its motion is retarded: in determination, there is an enlargement of the vessels, and an accelerated flow through them of an increased quantity of blood. In Inflammation, there are in addition certain changes in the vessels, in the blood, and in the adjacent tissues, which give to it its distinctive characters.

The phenomena of inflammation, as studied in the transparent tissues in some of the lower animals, such as the wing of the bat, or the web of a frog's foot, or the mesentery of the same animal, are as follows. On the application of an irritant, such as the point of a needle or a weak solution of salt or cold water, there is produced momentary contraction of the small arteries, followed by dilatation; the veins also become dilated; the flow of blood, which is at first accelerated, soon becomes retarded; and stasis or stagnation occurs at points, commencing in the capillaries, and extending to the veins and arteries. At the points of stasis, there is an aggregation of the red and the white corpuscles of the blood, which appear to block up the vessels; the red corpuscles, according to Cohnheim, chiefly occupying the arteries, and the white ones the veins. Around the centre of stagnation there is a retarded flow of blood, in which inflammatory area the corpuscles are seen to move languidly; and beyond this there is a rapid rush of an increased quantity of blood.

These are the *general* phenomena presented by the blood-vessels and their contents in an inflamed part when observed under the microscope. But in order to become acquainted with all the details of the inflammatory process we must analyse the condition of (1) the *vessels*, (2) the *blood*, and (3) the *tissues*.

1. **Vessels.**—The observations of Wharton Jones on the frog's foot, of Paget on the bat's wing, of Cohnheim on the mesentery of the frog, and other similar investigations, agree in showing that one of the initial phenomena of inflammation is dilatation of the small vessels. But whether this dilatation be primary or not, appears to depend greatly on the nature of the stimulant applied, and on other circumstances that cannot be readily appreciated. Sometimes the enlargement is seen to be preceded by temporary contraction; as when the part is irritated with the point of a needle, or by the application of a weak solution of salt, or cold water, or spirit of wine; while dilatation without any appreciable previous contraction is at once produced by the application of acetic acid or capsicum (Paget), vinum opii, or a strong solution of salt or of sulphate of copper (Wharton Jones), or by the mere exposure of the frog's mesentery to the air (Cohnheim). The solid sulphate of copper produces speedy, complete, and permanent contraction.

The dilatation affects not only the small arteries in the immediate vicinity of an inflamed part, but those also at a distance: this is shown by the increased strength and force of the pulsation in them, as may be readily observed in the pulsation of the digital arteries in a case of whitlow. That the rapidity of the current of blood from, as well as to, the inflamed part is increased, is proved by the observation of Lawrence, who found that in bleeding from both arms a patient with whitlow on one hand, more blood flowed from the inflamed than from the sound limb in the same space of time.

The dilatation of the vessels is at first attended with acceleration in the flow of blood, but, sooner or later, the blood-current is somewhat suddenly retarded and then gradually becomes slower until it stops altogether and stasis occurs. The retardation usually commences in the veins, along the sides of which the white corpuscles may be seen moving sluggishly along, as pointed out by Mr. Wharton Jones, while the liquor sanguinis and red corpuscles flow more rapidly on in a central current. As the retardation becomes more advanced, the white corpuscles crowd more and more into the veins. When stasis has occurred, the red corpuscles which have accumulated in the capillaries adhere closely to one another and to the sides of the vessel.

In consequence of the dilatation of the smaller arteries and capillaries, and the accumulation within them of large numbers of red corpuscles where, perhaps, only single files could penetrate before, parts previously pale may become brightly reddened. In this way for instance, the surface of the conjunctiva may, in a few hours, become very red, not by the formation of new vessels but by the accumulation of blood in previously existing ones that are dilated.

Besides undergoing dilatation, the arteries become elongated, tortuous, and waved, increasing in length as well as in diameter. The German pathologists—Kölliker and Hasse, whose views are confirmed by Paget and Wharton Jones—have observed that the arteries of the inflamed part have a tendency to become dilated at points, so as to present small varicose or aneurismal pouches projecting from their walls, or fusiform dilatations of their whole diameter. The changes would appear to arise from one of two causes: either that the vessel is constricted at points between which it maintains its normal width, and thus that the dilatation is apparent and not real; or, that it is actually dilated where it appears to be so. This appearance of partial dilatation is not, according to Virchow, confined to inflammation.

2. **The Blood.**—Simultaneously with the above-mentioned alterations in the condition of the blood-vessels, certain important changes take place in the red and white corpuscles and the liquor sanguinis. As we have already said, the capillaries are packed with closely adherent red corpuscles, but it is the white corpuscles in the veins that play the most important rôle in the inflammatory process. As long ago as 1841, Dr. C. J. B. Williams pointed out the fact that the white corpuscles are present in augmented numbers in the vessels of an inflamed part, but it was Dr. W. Addison who, in the same year, first described a passage of the white corpuscles out of the vessels. This observation was confirmed in 1846 by Dr. Augustus Waller, but appears to have been but little noticed until 1867, when Cohnheim, of Berlin, published an account of observations, in which he had seen both the red and the white corpuscles escaping through the coats of the vessels without rupture of these.

The passage of the red blood-corpuscles through the walls of the capillaries may be well seen, Cohnheim says, in the web of the frog's

foot, when congestion has been produced by tying the femoral vein. Stasis in some of the capillaries occurs in about a quarter of an hour; and in less than an hour there are seen irregular projections from the walls of the vessels. These projections go on increasing, and some of them soon separate themselves, and may be seen in the adjacent tissue as unmistakable red corpuscles. Stricker, who, with Kölliker, Sharpey, Billroth, Bastian, and others, confirms Cohnheim's observations, says that the injection of 10 per cent. solution of chloride of sodium favors the passage outwards of the red corpuscles so much as to cause hæmorrhagic maculæ. Cohnheim believes that the amount of red corpuscles which thus escape, varies with the number of capillaries possessed by the inflamed organ; being greater, for instance, in pneumonia than in inflammation of the mesentery.

The passage of the white corpuscles through the walls of the vessels is described as taking place in the following manner. If the white corpuscles be carefully watched, some of them may be seen, after a short time, to pass through the wall of the vein against which they have been collected. This passage through is accompanied by striking amœboid changes of shape. A small knob may be seen, for instance, outside the wall, opposite to a spot where a white corpuscle is clinging to it within. The knob outside grows larger and larger, while the corpuscle inside becomes smaller, till it finally vanishes by passing altogether through the wall. In the capillaries, both red and white corpuscles pass out: in the veins only the latter. We shall have to refer again to this migration of the white corpuscles when we come to speak of suppuration, in which process it appears to bear an important part.

Regarding the manner in which the corpuscles escape through the unruptured walls of the vessels, there is not as yet an agreement among those who admit the occurrence of the migration. Cohnheim, for instance, says that they pass by their amœboid movement through stomata between the endothelial cells of which the vascular wall is composed, and that their exit is aided by pressure: Stricker and Prussak describe the process as effected by an "active state" of the wall of the vessel, which consists of a homogeneous extensile protoplasm. Bastian ascribes the migration to amœboid movements of the corpuscles, such as were described in 1863 by Recklinghausen; and Billroth conjectures that the emigration of the colorless corpuscles may be facilitated by softening of the vascular walls.

Associated with the migration of the white and red corpuscles through the walls of the vessel, is an exudation of a highly albuminous and fibrinous fluid, derived from the liquor sanguinis, and known as *inflammatory effusion*. The fluid which thus sweats, as it were, from the vessels of inflamed tissue, is rich in cells and molecules. The question of the origin of these cell-structures in inflammatory effusions is a vexed one, and has at different periods received different answers. According to one school of pathologists, of which Hunter, Rokitansky, Hughes Bennett, and Paget, may be regarded the chief representatives, the molecules first form in the plastic or coagulable lymph. The molecules then aggregate themselves into nuclei, and the nuclei are developed into cells. Virchow, however, has opposed this view, and alleged that the cells arise from the multiplication and proliferation of the nucleated corpuscles of an inflamed part, and never from a spontaneous generation in the effused fluid. Even this explanation, which gained in a short time a very wide acceptance, received a rude shock when Cohnheim, in 1867, published an account of his observations of the escape from the veins of white corpuscles during

the process of inflammation. It is true that Cohnheim did not himself, at first, affirm that all the cell-structures were the result of the emigration of white blood-corpuscles, but his doctrines rapidly gained ground, and by some of the more ardent of the disciples were deemed capable of universal application. There can, however, be very little doubt that, although the migration of blood-corpuscles accounts for a large proportion of the cellular and molecular elements in inflammatory effusion, some, at least, are derived from the proliferating tissue-elements themselves.

Another account of the origin of these cells has been given by Dr. Lionel Beale, who alleges that they arise from the *germinal material* which exists as nuclei or minute granules in the blood and tissues. Be this as it may, the nature and quantity of the exudation, which differs from liquor sanguinis inasmuch as it usually contains a larger proportion of albuminous and fibrinous material and also an excess of chlorides and phosphates, will vary with the tissue inflamed and the degree of inflammation. In compact or non-vascular tissues the effusion is small in amount, but in loose and vascular tissues the effusion may be very great.

3. The **Tissues.**—As already intimated, important changes take place in the nutrition of the tissues during the inflammatory process. There is, in fact, an increased but perverted nutritive activity of the tissue-elements. The inflamed tissue is swollen and infiltrated, and greatly reduced in resistance and coherence, even dense hard structures becoming juicy and soft. The tissue-elements are swollen, while the nuclei and cells undergo rapid proliferation, and scattered about are large numbers of amœboid wandering cells, derived from the nuclei of the connective tissue and from the blood.

But the nutritive activity is not increased equally in all tissues. In epithelial tissues, and especially in mucous membranes, there is a rapid development of cells which, with the liquid effusion that is thrown off with it, constitutes what is known as *catarrh*. In hard non-vascular tissues, such as cartilage, there may be very little tendency to multiplication of the cellular elements.

These are the principal changes met with in the vessels, blood, and tissues of the affected part. The nerves have doubtless an important influence, the precise nature and extent of which are not yet thoroughly understood. Lister has observed that the tissues of the part are in a state of impaired nutrition and diminished functional activity; they "have suffered a diminution of power to discharge the offices peculiar to them as components of the healthy animal frame."

In what relation, as to order, do the phenomena of inflammation stand to each other? Stricker, who has ably investigated this matter by experiment, believes that the preliminary step is a morbid influence on the vessels, either direct or through the vascular nerves, originating within or without the organism; and that there then follow:—1. Local disturbance of circulation; 2. Increased exudation of the fluid and formed elements (corpuscles) of the blood; 3. Disturbed nutrition of the part; 4. Increase of cellular elements. This brings us to the stage of suppuration, of which we shall have to speak hereafter.

Symptoms of Inflammation.—These are *local* and *constitutional*. To establish the existence of the inflammatory process, it is necessary that the actions constituting it should continue for some length of time; as the changes gradually pass from simple hyperæmia into inflammation, it is difficult to say, except by the persistence and intensity of the symptoms, that this process has actually commenced.

The **Local Signs** of inflammation may be referred to five heads: viz., 1. *Alteration in Color;* 2. *Alteration in Size;* 3. *Modification of Sensation;* 4. *Increase of Temperature;* and 5. *Modification of Function of the Part Affected.* Certain of these conditions may occur separately, or two or more may be associated together, without the existence of inflammation; but it is the peculiar grouping together of them all that most distinctly characterises the presence of this pathological condition. The relative intensity of these changes varies greatly, according to the tissue which is the seat of the inflammation; thus, in inflammation of mucous membranes and of the skin, the alteration in color is most marked; in inflammation of the areolar tissue, the change in size always attracts special attention; and when a fibrous tissue is inflamed, its sensibility becomes greatly increased. It must not be forgotten, however, that one or other of these signs may be absent, especially pain and heat.

1. **Alteration of Color** is an invariable local sign of inflammation, and one of the earliest and most striking; parts that are naturally perfectly pale, as the ocular conjunctiva, assuming the most vivid crimson color when inflamed. Some textures, though they change in color, do not become red. Thus, the iris, when inflamed, assumes a greyish or brownish tinge; and the mucous membrane of the bladder, and of a portion of intestine, often becomes slate colored. The redness of inflammation varies from a bright crimson to a dull purple, the tint depending greatly upon the state of the constitution, and upon the presence of more or less congestion. The duller and darker the tint, the more local congestion and constitutional depression do we usually find. The redness is evidently due, in the earlier stages of the disease, to the dilatation of the vessels, and the increased accumulation of red corpuscles. In some low or asthenic forms of the disease, the coloring matter of the blood appears to undergo changes that allow its ready transudation through the walls of the vessels, or perhaps there is an increased migration of the red corpuscles; and in some chronic cases the vascularisation of the products of inflammation tends to render the coloration more enduring.

2 **Alteration in Size.**—The swelling of inflamed tissues is due in the first instance to the increased afflux of blood, and to the exudation of red and white corpuscles and liquor sanguinis. But sooner or later the swelling becomes still greater, by the increase in size and number of the tissue-elements of the affected area.

The swelling varies greatly in different localities. It is greatest in loose textures, and least in those which are firm and dense. Thus, for instance, in inflammation of the areolar tissue of the scrotum, the swelling is much greater than in inflammation of the testes. The inflammation of the conjunctiva occasions great swelling, that of the sclerotic but little. In dense hard structures, such as bone and ligament, there is, of course, very little swelling. If the inflammation become chronic, the swelling may terminate in permanent hypertrophy, or thickening, as will hereafter be described.

3. **Modification of Sensibility.**—There is in inflammation always more or less pain, which is due partly to increased sensibility of the nerves, but chiefly to the pressure exercised on their terminal branches by the dilated blood-vessels, and by the exudatory matters.

In inflammation of organs of special sense, instead of actual pain there may be some alteration in the special nervous sensibility of the diseased organ. When the eye is inflamed, subjective flashes of light may be seen; when the ear is diseased, there may be noises of various kinds.

In inflammation of the bladder, there is a constant desire to expel urine; and in inflammation of the rectum, there are frequent attempts at defæcation. In the latter instances, however, there is often an undue irritability of the nerves of the affected parts rather than mere pain.

Pain is one of the most prominent symptoms of inflammation, and its existence serves an useful purpose by preventing the patient from using or moving the inflamed part. The intensity of the pain depends more upon the structure affected than on the violence of the inflammation, being, as a general rule, greater in proportion as the tissue affected is incapable of yielding to the pressure exercised on it by the dilated vessels and the effused matters. Hence, in general, the intensity of the pain is in the inverse ratio of the swelling of the part. Thus, the pain of inflamed bone or fibrous tissue is excessive; that of areolar membrane trifling. In erysipelas of the scalp, most pain is experienced in the ears; the pain of an inflamed sclerotic is far greater than that of a conjunctiva similarly affected. In some forms of inflammation pain can scarcely be said to exist, though the disease may assume the most destructive form. Thus, in certain inflammatory affections of the throat and of the peritoneum, there is little or no pain.

The character of pain varies according to the seat of inflammation. When mucous membranes suffer, it is often of an itching or burning character, as in conjunctivitis; when the serous membranes of the chest or abdomen are attacked, it is lancinating or stabbing; aching in osteitis; throbbing when pus is about to form; sickening when the testis or the kidney is affected. Inflammatory pain is always increased by pressure; when it is principally produced by pressure, the part is said to be *tender*. This tenderness is of great service in a diagnostic point of view; it may be elicited by direct pressure upon the part, as by squeezing an inflamed testis, or by pressing two surfaces together, as in an inflamed joint. In inflammatory pain, especially of osseous and fibrous tissues, there is very commonly nocturnal exacerbation.

It is important to bear in mind that inflammatory pain is often seated not merely in the part affected, but radiates extensively along the course of the nerves, the terminal branches of which are implicated to a limited extent perhaps. Thus, in inflammation of the testis there is pain in the loins and groins. In deep-seated ophthalmia there may be exquisite pain along the branches of the fifth nerve over the whole side of the head or face, in consequence of the ciliary branches of the nasal, which are distributed to the iris and choroid, becoming compressed or stretched.

4. The **Temperature** of an inflamed part usually rises above its normal standard. Hunter has, however, remarked that it does not increase above that of the left ventricle; thus, in a case of hydrocele, he found the tunica vaginalis at 92° Fahr. before inflammation had been excited in it, and at 98¾° after it had been set up. In a case of extravasation of urine, with severe inflammation, I found the temperature in the incision made in the perinæum 98° Fahr. Simon and Dr. Edmund Montgomery, from experiments with a thermo-electric apparatus, have found: "1. That the arterial blood supplied to an inflamed limb is less warm than the focus of inflammation itself; 2. That the venous blood returning from an inflamed limb, though less warm than the focus of inflammation, is warmer than the arterial blood supplied to the limb; and 3. That the venous blood returning from an inflamed limb is warmer than the corresponding current on the opposite side of the body." It is probable that there is always some local increase of heat in inflammation; although the observations of Billroth, O. Weber, and others, would

rexia = Inflammatory fever [illegible]

appear to denote that the occurrence is not constant. The rise of temperature is probably but moderate; to the patient, however, it appears greater than it is in reality—as Travers truly remarks, "The nerves measure the sensation and not the degree of heat." In many cases the sensation of the patient is that of *burning* in the part, although the actual rise in temperature may be but trifling. This is owing to the exalted sensibility of the nerves.

How far the increased temperature is dependent on the mere hyperæmia or on the changes going on between the blood and tissues of the part, is not yet decided. It must be remembered, however, that in all conditions of severe exercise that part of the body in which determination of blood takes place, as also in blushing or parturition, the temperature rises. This can clearly not be owing to any production of heat during respiration, which may account for the *general* heat of the blood, but not for its *local* increase.

5. **Modification of Function, Use, or Nutrition** invariably occurs in inflammation, and furnishes important local symptoms. The *Functional Activity* of an organ is increased but perverted, in the earlier stages at least of inflammation; and the character of the secretions from the part is materially modified. Thus, when the mucous membrane of the urethra is inflamed, there is copious discharge from it; and this is not mucous, but purulent.

The *Use* of the part affected is greatly interfered with; thus the bladder can contain no urine, the eye cannot bear the light, nor can a joint be moved, when inflamed.

The *Nutrition* of the inflamed tissues is modified or arrested; hence, wasting, softening, or contraction are common accompaniments of inflammation.

Constitutional Symptoms.—The severity of the constitutional symptoms will depend on the intensity and the extent of the inflammation; on the vital importance of the part affected by it; on the amount of local irritation; and on the origin of the inflammation from external or from internal causes. Thus, a moderate degree of inflammation in a part of no vital importance, as the skin, and occasioned by an external cause, as an abrasion, gives rise to no appreciable constitutional disturbance. But if the inflammation be wide-spread, as in diffused erysipelas; or if it arise from constitutional causes; or if there be much local tension, as in whitlow; or if the part affected be of great importance, as the larynx or the kidney, then the general symptoms become proportionally severe.

The constitutional disturbance in inflammation always assumes the form of fever—**Inflammatory or Symptomatic Fever**, or **Pyrexia.** Although the blood may previously have been in a diseased state, and so have predisposed the patient to the occurrence of an inflammation, the inflammatory fever is invariably secondary, being consecutive to the local affection. It is the true *surgical* fever, no febrile disturbance occurring in surgical practice, except as a consequence of, and secondary to, local disease or injury. This fever appears to be due primarily to the deterioration of the blood, occasioned by the accumulation in it of the products of the rapid waste of the tissues that are the seat of the inflammation, owing to their being poured into it more quickly than they can be eliminated by the different emunctories of the system. The presence, in excessive quantity, of this effete matter in the blood, occasions congestion and disturbance of function of the excretory organs, and is liable to give rise to consecutive inflammations, sometimes of a low type, in various viscera.

Inflammatory fever, or pyrexia, presents an infinite variety of forms; the type which it assumes being finally dependent, 1st, on the state of the blood; 2nd, on the condition of the nervous system; and, 3rd, on the occurrence of certain local or specific symptoms determined by the seat of the inflammation. These varieties in the type of the fever arrange themselves practically into three classes: 1. *Sthenic*, or typical inflammatory fever; 2. *Asthenic*, or typhoid fever; 3. *Irritative*, or nervous fever. In all these forms of fever there are three distinct stages: those of invasion, exacerbation, and decline. In practice, the recognition of the type or form that the constitutional fever of inflammation assumes is of the first consequence. The treatment of the patient, irrespective of the topical means that the special local affection may require, being altogether determined by the particular form that the concomitant constitutional disturbance assumes, it cannot be too sedulously borne in mind that the local signs, "the redness, swelling, heat, and pain," do not in themselves comprise all the morbid phenomena of inflammation; there is always accompanying constitutional disturbance, sometimes preceding or predisposing to the development of the local signs, in all cases modifying their characters, and invariably, whether pre-existing or not, increased by the excitation of the local disease. It is the character of this constitutional disturbance or fever that will at last determine the kind of treatment to be adopted; and it consequently requires to be closely studied.

1. **Sthenic Inflammatory Fever**, true pyrexia, occurs in individuals of healthy constitution, young or middle-aged, in connection with those forms of inflammation that are of an active, acute character, and not unfrequently consequent upon injury.

In this form of fever the stage of invasion is very slightly marked, though it always occurs. There are shiverings, with some slight depression of the nervous system; but these symptoms may be so transient as to escape observation entirely, and speedily terminate in the stage of febrile reaction. In the majority of cases, it is not until the constitutional disturbance has reached this stage that it attracts attention. The skin is now hot and usually dry, and there is a rise in the temperature of the body of from 2° to 5° Fahr. The pulse is full, bounding or thrilling, and quickened by thirty or forty beats in the minute above its normal rate. If the tissue or organ affected be a mucous membrane, the skin, or a glandular structure, as the testis or mamma, the pulse is compressible, though full; if a serous membrane be inflamed, it is small, incompressible, and wiry; if a fibrous tissue be the seat of disease, it is hard and full. The secretions are arrested or diminished in quantity; hence the urine is high-colored and acid, containing an excess of uric acid but a marked deficiency of chlorides; the bowels are confined, the tongue coated with a white fur, and the mouth clammy, usually with much thirst. There is a feeling of great languor, and the head is often heavy and hot.

The blood in inflammation undergoes important changes, both in the liquor sanguinis and the corpuscles.

In the *liquor sanguinis* the proportion of albumen and of saline matter is somewhat below the natural standard, while that of the water is increased. The increased thinness of the blood was long ago pointed out by Hewson. The amount of spontaneously coagulating material—or fibrin—is increased: according to Andral and Gavarret, it may rise from $2\frac{1}{2}$ per 1000 to 10 per 1000.

When inflammatory blood is drawn from the body, it *coagulates* more

slowly than healthy blood ; the coagulum also is harder and smaller, and the quantity of serum apparently greater. The surface of the coagulum is commonly covered by a tough layer of yellow fibrinous matter, the *buffy coat;* and its upper surface is depressed in the centre, having elevated edges, being *cupped*, as it is usually termed. The "buff" and "cup" were formerly much used as guides in estimating the intensity of the inflammation ; it has, however, been shown that buff may occur in certain conditions of the system, as in plethora, or pregnancy, or after exercise, without the occurrence of inflammation ; and that the tissue affected, rather than the severity of the inflammation, determines its quantity ; thus, it is the greatest when the fibrous or serous tissues, at least when the mucous or tegumentary, are inflamed. The cupped shape of the clot is in some degree dependent on the shape of the vessel into which the blood is received, being most marked when the vessel is rather narrow and deep.

The *blood-corpuscles*, both red and white, have been already described as collecting in great numbers in the vessels of the inflamed part. Does this indicate an increase of both or either of these in the general mass of the blood? The *red* particles, according to Andral and Gavarret, are increased in quantity in the early stages of inflammation ; but as the disease advances they fall below the natural standard, as Wharton Jones and Simon have pointed out. They manifest increased adhesiveness, and a tendency to aggregation into clusters by cohesion of their flat surfaces, in blood removed from the body as well as in that within the vessels. As to the *white* corpuscles, we know they are present in augmented numbers in the vessels of the inflamed part: whether, however, they are really more numerous in the blood in inflammation, is doubted by Paget, Simon, and others. That an increase of the white corpuscles is not an absolutely distinctive characteristic of inflammation, seems indicated by their excessive formation in leucocythæmia.

As the fever declines, if a favorable termination occur, the system not uncommonly relieves itself by a critical evacuation :—from the skin, by abundant acid perspiration ; from the kidneys, by the free disposition of lithates in the urine ; from the bowels by diarrhœa ; and from some of the mucous surfaces, by hæmorrhage. The tongue cleans, the pulse lessens in frequency and in strength, the secretions become freer, the thirst diminishes, and strength and appetite return. Should the fever not take a favorable course, death may ensue by the occurrence of serious visceral complications ; the lungs and brain being especially apt to suffer, becoming the seats of fatal inflammatory mischief; or the sthenic form of the disease may gradually merge into those types that are characterized by debility and irritation.

2. **Asthenic Inflammatory Fever** principally occurs in those individuals whose constitutions are broken by privation, dissipation, or by any of the general depressing causes of disease, as grief, anxiety, or long residence in a vitiated atmosphere. In constitutions such as these, frequently met with in all classes, but especially amongst the poorer residents in large towns, inflammatory fever almost invariably assumes a low type. There is also, in this variety of the disease, a special tendency to complication with visceral mischief; the lungs being peculiarly apt to become affected by a low or congestive form of pneumonia.

The asthenic form of the disease may come on as a sequence of the sthenic variety ; the symptoms gradually merging into those of a low form, and being characterized by debility rather than by strength of action ; the pulse becoming weaker though its frequency is kept up, the

tongue becoming brown and dry, with a tendency to the early supervention of delirium of a muttering kind.

When the fever assumes the asthenic form from the very first, the period of depression is strongly marked, and often prolonged for many hours, reaction coming on gradually and imperfectly, and alternating with the depression against which the system is struggling. Even when fully established, the symptoms of the stage of reaction are not very active: there is throughout an appearance of heaviness or stupor about the patient, with very little activity of the intellectual faculties, and an early tendency to delirium of a low form, especially at night; the pulse is feeble, though quick; the skin is either moderately hot, or else pungent and burning; the temperature is from 1° to 3° Fahr. above normal; the tongue brown and dry, with sordes rapidly accumulating about the lips and teeth; the cheeks are often flushed, and the eyes bright and staring. As the third stage comes on, if the patient recover, critical evacuations of a hæmorrhagic or diarrhœal character appear; the pulse subsides, the tongue gradually and slowly cleans from the sides and tip, and the patient slowly and imperfectly regains his strength; the convalescence being often interrupted by intercurrent disease, and the powers of the constitution being frequently broken for months, or for life. If the disease take an unfavorable course, the weakness of pulse and the dark incrustation of the tongue increase; the skin becomes cold; hiccup, subsultus, dyspnœa, or coma supervene; and death occurs from exhaustion, or as the result of visceral complication.

3. **Irritative Fever** is of a less specific type. It is usually associated with the asthenic form, the nervous system being especially implicated. It occurs in individuals whose mental powers have been overwrought, or whose nervous systems have been irritated and shattered by intemperance. It is characterized by irregularity in its actions, by sudden exacerbations, and by a rapid decline. The several febrile symptoms run high in the early stages. The pulse soon becomes sharp and small; there are high delirium of a furious kind, wildness of eye, and heat of head. But these symptoms soon give way to signs of debility and exhaustion, and death takes place from coma and cerebral irritation.

Terminations of Acute Inflammation.—There are two ways in which inflammation may terminate without leaving any traces of its presence in the parts affected: these are by—1. *Resolution*, and 2. *Metastasis*.

1. The termination by **Resolution** simply means a return to health. The pain and heat first subside, the swelling lessens, and lastly the redness passes away: the constitutional symptoms also disappear. With regard to the more intimate changes in the part itself, it will be seen that the dilated vessels contract, and the stagnant masses of blood-discs are pushed on and broken up by streams finding their way into and against them. Absorption, which had been held in check during the continuance of inflammation, comes into play and removes the extravasated matters; and secretion becomes more active, and helps to unload the part. Resolution may in this way be complete; or it may go on to a certain point and then stop, leaving one or other of the effects that will immediately be mentioned.

2. By **Metastasis** is meant a change in the seat of the inflammation —its sudden and complete disappearance from one part and appearance in another. This is of extremely rare occurrence; it is occasionally seen, however, as in the inflammation of the testis that suddenly supervenes on the disappearance of gonorrhœal discharge.

Besides these true terminations, inflammation commonly passes from

the ordinary and primary condition into some other form of the disease. Thus, for instance, the acute disease may merge into the chronic form; if plastic matter or lymph be thrown out, *adhesive* inflammation is said to have occurred; when pus is produced, we have *suppurative* inflammation; when an ulcer forms, *ulcerative* inflammation is said to have set in; and when the inflammatory action is of such intensity as to cause the death of the part affected, *gangrenous* inflammation has occurred. These different conditions vary so widely from each other, as to require separate and distinct consideration.

Extension.—When inflammation has once been set up in a part, it may extend to other portions of the system in four distinct ways.

1. **Local extension** may occur by the inflammation spreading along the tissue affected in its **continuity**; as, for instance, along the skin, areolar tissue, or mucous membrane.

2. Inflammation may also spread by **contiguity** of tissue, passing from one affected structure to an adjacent healthy one; thus we see the opposite surfaces of an inflamed joint involved in disease at opposed points. In such cases, the part first inflamed probably acts as an irritant to that with which it comes into contact, and in this way induces inflammation in the latter.

3. Inflammation may extend to distant parts through the medium of the **blood**; this fluid being altered and depraved, and increasing the liability to inflammation in other parts, as in some of the erratic forms of erysipelas. Or the blood may convey the products of inflammation to a distance, as in phlebitis, and thus give rise to numerous centres of inflammation.

4. Inflammation may appear in a distant part in consequence of **metastasis**, as has been already stated.

Effects of Inflammation.—In speaking of the local symptoms of inflammation, reference was made to the occurrence of *effusions* of various kinds, and of modifications in the *secretions* of the part affected. These effects must now be examined in greater detail.

Effusions are not invariably due to inflammation. Venous congestion will produce an excessive transudation of fluid of a more or less watery character, constituting *œdema* in the areolar tissue, and *dropsy* in serous or synovial cavities. Thus, if the veins of the leg be compressed, œdema of the foot will result: if those of the liver be obstructed, ascites will follow. Congestion of the renal veins produces albuminuria. If the pressure on the vessels be great, the capillaries may be distended till they rupture, giving rise to effusion of blood, as in some forms of epistaxis and hæmaturia.

The proper effusions of inflammation are—1. *Blood;* 2. *Liquor Sanguinis;* 3. *Serum.* These effusions are in a great measure mechanical, depending on the dynamic state of the vessels, though doubtless in many instances modified by other causes of a vital character. Fibrine, or lymph, though usually spoken of as an inflammatory effusion, differs remarkably in its vital characters from the rest, and will be considered elsewhere.

The frequency with which one or other form of effusion occurs in different tissues, or organs, varies greatly. Paget observes, "each tissue has its proper mode and products of inflammation;" hence particular kinds of effusions are very rare in some, although of common occurrence in other parts.

1. **Effusion of Blood** often occurs in small quantity, tinging the other products of inflammation. When this is the case, the coloring

matter is broken up and dissolved, a condition indicative of a low state of the constitutional powers. In other cases, the hæmorrhage may be abundant, the character of the blood being but little changed. This effusion is dependent upon overdistension of the vessels, with softening of the tissues, giving rise to rupture of the capillaries. Hæmorrhage of this kind most frequently occurs from mucous surfaces, which readily bleed when inflamed. It may also happen from the rupture of new vessels in freshly deposited lymph; or it may arise from migration of the red corpuscles through the walls of the capillaries.

2. **Effusion of Liquor Sanguinis.**—In this case, the fluid parts of the blood transude, leaving the corpuscles behind. It is occasionally met with in so-called serous effusions, into the tunica vaginalis for instance; so also the serum contained in the bleb of a blister is really liquor sanguinis: and Paget has found that in this there is most fibrine when there is most strength of constitution. This fluid is not uncommonly met with in the subcutaneous and submucous areolar tissues; about the glottis, and in the scrotum, for instance, giving rise to a gelatinous semi-transparent swelling of the part. In these cases, the more fluid portions are sometimes absorbed, leaving the fibrine, thus constituting the condition termed *solid œdema.* The fibrine in this effusion often does not coagulate so long as it is retained in the body; but when it is removed, solidification ensues.

3. **Serous or Albuminous Effusions** are very common in slight or subacute inflammations of serous and areolar tissues, giving rise to dropsies and œdema. They most frequently contain a small admixture of fibrine, approaching somewhat to the characters of the last-mentioned effusion. The quantity of the fibrine contained in them is usually a measure of the degree of the inflammation. These serous accumulations form and are absorbed with great rapidity, and their absorption is usually most rapid when the fibrination is least.

Closely connected with the occurrence of these effusions are changes in the consistence of the part affected: these, however, being in part the results of the local disturbance of nutrition, which is one of the factors of the inflammatory process. These changes may be of two kinds: **Induration**, chiefly as a consequence of chronic inflammation, occasioned by the turgescent state of the vessels of the part, or the effusion of plastic matter within it; and **Softening**, chiefly the result of acute inflammation, depending partly on the infiltration of effused liquids into the textures, and partly on a disintegration of the substance, which produce a diminution of the consistence even of the hardest tissues, by impairment of their nutrition: thus an inflamed bone may be cut and pared down with a knife, or the ligaments of an inflamed joint become so soft as to admit of spontaneous dislocation. This softening may ultimately lead to the *interstitial absorption* of a part, which becomes shrunken and contracted after inflammation. **Ulceration**, as will hereafter be fully stated, is not an unfrequent consequence of this softening and atrophy, as we see in those joints that have undergone inflammation.

Interstitial absorption and **gradual wasting** of a part, without previous softening, often occur as an effect of inflammation. Thus, a blow on the hip may occasion absorption and shortening of the neck of the femur.

Loss of transparency in structures that are normally translucent is a common effect of inflammation, as may every day be observed in the cornea. In some cases this rather depends upon a modification of

nutrition than upon the deposit of new matter upon the part; in other cases, again, it proceeds from the deposition of fibrinous matter.

Secretions of Tissues and Organs undergo changes in quantity and quality, under the influence of inflammation. The quantity is at first increased; but during the active stage of the inflammation, when there is much tension, it becomes diminished, the part being almost dry; as the inflammatory action subsides, and relaxation of the vessels ensues, it again becomes increased.

The alteration in quality in secretions from *glands* is chiefly due to the admixture of morbid secretions from the mucous membrane. When a *serous membrane* is inflamed, the secretion not only accumulates in greatly increased quantity, as in acute hydrocele, but it becomes turbid from the admixture of flakes of lymph, which are sometimes so abundant as to give it a puriform appearance. In other cases true pus is formed, as in inflammation of the cornea and iris, terminating in hypopyon. In inflammation of the *areolar tissue* the quantity of fluid is either simply increased, or it becomes fibrinous, occasioning solid œdema and induration. In inflammation of the *mucous membrane* the most important modifications of secretion occur. The first effect is to cause the transudation of a serous fluid from the mucous membrane, the secretion becoming clear, watery, and abundant. As the inflammation increases, exudation-corpuscles and large quantities of epithelial scales are thrown off, and, mixing with the mucus, make it viscid and tenacious—*ropy*, as it is termed. In the more advanced stages we find pus and exudation-corpuscles with epithelial scales, constituting the various forms of muco-pus and of true purulent secretion.

VARIETIES OF INFLAMMATION.—The symptoms, terminations, and effects of inflammation that have just been described, are those which characterise the more acute or ordinary forms of the disease. In practice, however, we recognise many important varieties. These may be referred to three heads, as they affect its *Duration*, its *Intensity*, or its *Character*.

1. **Duration.**—The disease may be acute or chronic, varying from a few days to many years, being especially persistent in those structures that are naturally least vascular, as, for instance, bones and joints. Chronic inflammation will be described in a subsequent part of this chapter.

2. **Intensity.**—When the symptoms are well marked, the redness and heat great, the tension high, and perhaps the pain severe, with corresponding constitutional disturbance, the inflammation is said to be *active* or *acute;* when of a less intense character, it is termed *subacute;* and when there are merely redness and swelling, with little or no pain, and but slight constitutional disturbance, the disease is said to be of a *passive* kind. The intensity of the inflammation is commonly greater in proportion to the short duration of the disease, and less in the more chronic cases; but very frequently inflammation of short duration may be subacute or passive, whereas some very chronic forms may retain great activity, and are especially liable to recurrent active attacks.

3. **Character.**—If the inflammation be circumscribed, occurring in a healthy constitution, and tending after a moderate time to terminate in resolution, it is called *healthy* or *phlegmonous.* If the vessels become distended and dilated, and the blood circulate slowly, the redness being of a purplish tinge, and the swelling considerable, with but little heat, the disease is said to be *congestive.* Of *unhealthy* inflammations there are numerous varieties: the *diffuse*, having a tendency to spread widely unchecked; the *strumous*, modified by scrofula; and the *specific* inflam-

mations that arise from special causes, and are frequently capable of self-propagation.

Causes of Inflammation.—The causes of inflammation may be divided, like those of all other diseases, into *predisposing* and *exciting;* and these again may either be strictly local, or may act locally through the medium of the constitution.

Local Predisposing Causes.—Though every tissue of the body is susceptible to inflammation, yet some parts are more liable to it than others. This cannot be owing to any greater degree of vascularity; for we find that the tissues lining the interior of a joint more readily and more violently inflame, though they are almost extravascular, than a portion of the mucous membrane, which is abundantly supplied with vessels. Indeed, serous and synovial membranes are more liable than most other tissues to inflammatory excitement. Whatever the reason of this may be, there are two sets of causes that more especially predispose tissues to inflammation.

Thus, habitual overuse or overstimulation of a part, by producing determination of blood, may give rise to inflammation.

When a part, having once been the seat of inflammation, has been left in a weakened or impaired state, it will be more liable to the occurrence of a second attack of inflammation, having less resisting power; hence, also, subsequent attacks are induced by less active exciting causes than were required at first to call the disease into action; we see this in the inflammatory affections of the eyes and joints. Then, again, a tendency to local congestion or stasis will dispose to inflammation, very slight overstimulation inducing the disease when the vessels of the part are already overloaded, and the reparative power impaired; this is often seen in the case of varicose veins, the congestion of the skin readily running into inflammation.

Constitutional Predisposing Causes.—It is of great consequence to ascertain whether any constitutional predisposition to inflammation exists; and if so, what its precise nature is; for the progress of the local affection will in a great measure be dependent on the amount of constitutional predisposition.

The constitutional predisposing causes are of two kinds.

1. Inflammation is predisposed to by a state of general *overstimulation of the vascular and nervous systems.* This condition may be hereditary, as in persons of the sanguine temperament, or it may be dependent on youth or sex; or it may be acquired by habitual indulgence at table, the induction of plethora and gout giving rise to a habit of body that is peculiarly favorable to the occurrence of inflammation. Inflammations occurring in this habit of body are usually sthenic, though not unfrequently accompanied, in the case of persons accustomed to alcoholic stimulants, by irritative fever.

2. A directly opposite condition of the system equally disposes the person to inflammatory attacks. Thus a state of *vascular and nervous depression*, by lessening the reactive power of the constitution, causing a loss of tone in the vascular system with ready tendency to congestion of the vessels, and to stagnation of blood, disposes to inflammation. In this way inflammatory actions are especially apt to occur in scrofulous patients, in whom the general powers are enfeebled; and in such individuals they occur under the influence of exciting causes less in degree than those which affect persons in whom nutrition is more actively carried on. Here inflammation usually assumes the passive, congestive, or asthenic forms.

Exciting Causes.—These are very numerous and exciting in their action. Commonly, *mechanical injuries* are those that occasion surgical inflammations; which are, indeed, set up by nature as the means of repairing the effects of the injury.

Chemical agencies, as the application of caustics and undue extremes of heat and cold, are also amongst the most common exciting causes. The application of the virus of certain *morbid poisons*, as of syphilis and the malignant pustule, directly occasions it. And lastly, certain *states of the blood* give rise to it, as we observe in those conditions of the system in which boils, carbuncles, &c., are produced.

Inflammation will often, though not necessarily, vary greatly in character according as it rises from a constitutional or a traumatic cause. When an inflammation of an organ, as of the lung, arises from an idiopathic or constitutional cause, a predisposition must previously have existed in the system, leading under the influence of slight variations of external circumstances, as exposure to a draught of cold air or to wet, to the development of the local disease. The inflammation will, therefore, usually be prone to become wide-spread, and frequently has a tendency to assume a low type. In the case of a similar inflammation, as of the lung, following an injury, as a wound of the organ, in an otherwise perfectly healthy subject, the disease will be localised in the seat of injury; having little tendency to spread, and usually assuming the active sthenic character. If, however, the constitution be in a bad state, and the blood unhealthy, or if the patient be exposed to unfavorable hygienic conditions, a very slight injury may develop a wide-spread inflammation, which will then always assume a low and usually an erysipelatous form.

Treatment of Inflammation.—It is interesting, and possibly practically useful, to study the inflammatory process pathologically and physiologically, and to recognise in it a modification or aberration of nutrition rather than a distinct disease. Yet when we have to deal with it therapeutically or surgically, when we meet with it in the hospital-ward and not in the dead-house, or in the web of the frog's foot in the physiological laboratory, we must be prepared to encounter it as a disease often of the most fatal and destructive character; always dangerous to life or to organ when it passes certain limits; often dangerous to integrity of structure, even in its simplest forms; and, when affecting certain constitutions, as the strumous, liable to become most difficult of cure and inveterately chronic. Hence I shall speak of inflammation as we meet with it in surgical practice as essentially and substantially a *disease*, to be treated, cured, or removed as such.

The **Treatment of Inflammation** may be divided into the *Preventive* and the *Curative*.

The **Preventive Treatment** can be employed only in inflammation supervening on injury. In it the principal point to be attended to is, the removal of the local and constitutional causes of irritation. By doing this, the occurrence of inflammation in a part that has been injured or otherwise disposed to its accession may be entirely prevented, or, if this be not accomplished, the inflammation may be much lessened in severity.

The *local preventive* treatment of inflammation is best carried out by the removal of all sources of irritation, by absolute rest of the part, and by the free application of cold. If the injury be superficial, and not very severe, lint dipped in cold water, frequently renewed, may be applied; or, if the skin be unbroken, an evaporating lotion may be used. Should a limb or joint be severely injured, cold irrigation will be a preferable

mode of reducing its temperature. This may most conveniently be done by suspending over the part a large wide-mouthed bottle full of water, in which a few pieces of ice may, if necessary, be put; one end of a skein of cotton, well wetted, is then allowed to hang in the water, whilst the other end is brought over the side of the bottle. This, acting as a syphon, causes a continual dropping upon the part to which the cold is to be applied (Fig. 69). In some cases the application of pounded ice

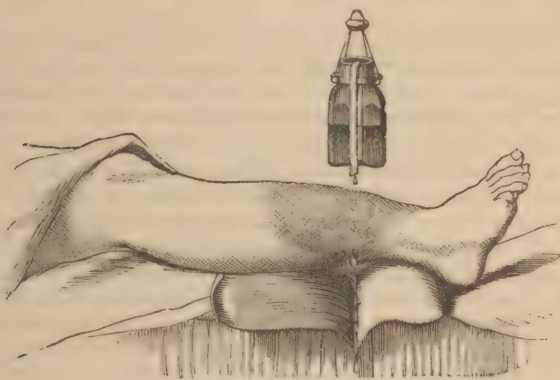


Fig. 69.—Irrigating Apparatus..

in a bladder, or of cold evaporating lotions, may be preferred to the irrigation. *Dry cold* may be advantageously substituted for the moist in many cases. It has the advantage of not soddening the skin, and is less likely to be followed by gangrene, which may result from the incautious or long-continued use of cold and moisture. The dry cold is best applied by putting pounded ice into a thin vulcanized India-rubber bag, as recommended by Esmarch.

At the same time all constitutional irritation must be removed by abstinence, rest, and a free aperient.

In undertaking the **Curative Treatment** of inflammation, the Surgeon must not allow himself to be led away by the name of the affection with which he has to do, but he must be influenced in the means that he adopts by the constitutional condition of the patient, by the type of the inflammatory fever, and by the state of the diseased part; for nothing presents greater variety than the management of the inflammatory process in different conditions of the patient, and in the different phases of the disease. We shall accordingly consider the treatment of acute inflammation as applied to the sthenic, the asthenic, and the irritative varieties of the disease.

Treatment of Acute Inflammation with Fever of the Sthenic Type.—In the treatment of this variety of the disease, active and energetic measures must early be had recourse to, especially if the patient be young and strong. There is no affection that is more under the control of the Surgeon than this when it occurs in a healthy constitution, and none in which more can be done by active means early employed. It is consequently of the first importance that precious time be not lost by the employment of inefficient measures; otherwise, important local changes and irremovable alterations of structure may ensue. It is also of great consequence to remove the disease fully; not only to subdue it, but to extinguish it, lest it degenerate into some of the more chronic, passive, and intractable forms.

The first thing to be attended to in the treatment of the sthenic, and of all the other varieties of inflammation, is the *removal of the cause*. Thus, rest must be afforded to a diseased joint, light withheld from an inflamed eye, and a foreign body taken out of the flesh in which it is lodged.

The next great indication is to lessen the determination of blood to the part. The measures for accomplishing this comprise what has been termed the *antiphlogistic* treatment. This consists of constitutional and local means.

Constitutional Treatment.—The most powerful and efficient means that we possess is certainly **Blood-letting**: and, when the inflammation is sufficiently extensive and severe, and the state of the patient's powers warrant it, we may have recourse to the abstraction of blood. But, as blood can easily be taken away, but cannot readily be restored, we should never remove it unnecessarily, lest permanent ill effects to the health ensue. Blood-letting is certainly not often required in the treatment of surgical inflammations; and it should be especially avoided in very young and in very old subjects, in the inhabitants of large towns generally, or in persons who suffer from inflammation of a specific character. It should never be employed unless an organ of great importance to the economy, as the lung or brain, for instance, be inflamed, or so injured that inflammation is imminent; or unless a tissue, like the transparent structure of the eye, be affected, in which case it is absolutely necessary, at any risk, to cut short an inflammation before it gives rise to a change of structure, which, however slight, would be fatal to the utility of the part. The quantity of blood that should be taken necessarily varies greatly, according to the age and constitution of the patient, and the nature of his disease; and it is of importance to bear in mind that, when blood-letting is really required, the system tolerates the loss of the vital fluid in a way that it does not otherwise. The effect produced on the pulse and on the system should be the guide to the quantity to be taken away. A decided impression should be produced by blood-letting, not so much on the frequency of the pulse, as on its character; *that* should guide us, and not the number of ounces drawn. The point to be obtained is the greatest effect upon the system with the least loss to the patient; hence the blood should be taken from a large orifice in the median basilic or the median cephalic vein, the patient sitting upright. In repeating the venesection, we must be guided by the impression that has been made upon the disease, and by the state of the pulse. By blood-letting, when it is indicated by the severity of the inflammation, or by the importance of the part affected, we not only lessen the force of the circulation, but we also abstract at once from the system a quantity of blood that has been deteriorated by an accumulation of the products of the waste of tissues. It is especially in those forms of inflammation, therefore, in which the blood is early and abundantly charged with these products, in which it is superfibrinated to a great extent, as in inflammation of serous membranes and of fibrous tissues, that blood-letting has been proved by experience to be of service.

Whether blood-letting be practised or not, we must endeavor to set the secretions free, and in this way to clear the blood of the morbid products accumulated in it. If we can bring about a full action from the liver or bowels, with copious bilious evacuations, abundant secretion of acid perspiration from the skin, or a copious discharge of urine loaded with lithates, we shall often at once cut short the disease. With these

objects in view, *purgatives*, *diaphoretics*, and *diuretics* are to be administered.

Purgatives should always be given early, except in some special cases of acute inflammation of the abdominal organs. They clear the intestinal canal, free the secretions, and equalise the circulation. In general, it will be found most advantageous to administer a mercurial, followed by a brisk saline purge; and this should be repeated from time to time during the progress of the case.

Diuretics and **diaphoretics** require to be administered frequently during the day. If the skin be hot and dry, antimonials should be given in small and repeated doses; these may advantageously be conjoined with, or replaced by salines, such as the citrate of potash, the acetate of ammonia, or nitre. In this way the force of the heart's action is lessened, and the skin and kidneys are called into active operation. It is also probable that the salines alter the constitution of the blood, dissolving the fibrine and lessening the quantity of water, both of which constituents are in excess in inflammation.

Aconite in small doses frequently repeated—one minim of the tincture every half hour for four hours and then every hour—exercises a most marked influence on simple inflammatory fever when there are no visceral complications. It lowers the force and frequency of the pulse, and produces speedy and copious sweating, to the infinite relief of the patient.

In many forms of sthenic inflammation, especially those which affect the serous and fibrous membranes, we do not possess a more efficient agent than **mercury**, administered, not as a purgative, but as an alterative to the system. And I confess that I can in no way give my adherence to the doctrines of those who, disregarding the daily evidence of professional experience, deny the utility of the preparations of this mineral in the treatment of certain forms of inflammatory disease. Mercurial remedies are of special service in aiding the operation of other medicines. Diuretics, diaphoretics, and purgatives, will frequently not act properly unless conjoined with a mercurial. In inflammation, the preparations of mercury act as direct antiphlogistic agents, lessening the quantity of fibrine in the blood, and equalising the circulation. They are of especial value in promoting the absorption of exudation-matters, more especially of lymph, as we may see happening under their influence in certain diseases of the eye. They appear to do this rather by lowering the vascular action of the part, and thus allowing the absorption, which had been arrested during the persistence of the inflammation, to be carried on, than by any special influence exercised over the effused material. Care, however, is required in the administration of mercury. In irritable or cachectic constitutions it should not be given at all, or not without great caution. It is best borne by strong constitutions, and in acute inflammation of the serous and fibrous tissues.

Calomel, blue pill, and powder of mercury with chalk, are the preparations usually employed when the mineral is given by the mouth. When it is administered endermically, the mercurial ointment is preferred; and the use of the mineral is in general continued until the gums become spongy, and a red line is formed at their edge; the patient experiencing a coppery taste in the mouth, and the breath becoming fetid. It is not necessary to induce profuse salivation.

It is especially the combination of **calomel with opium** that produces the most beneficial effects in the treatment of active surgical inflammation. One or two grains of calomel, and half a grain or a

grain of opium, or five grains of Dover's powder with three of mercury and chalk, every fourth or sixth hour, tranquillise the system and lessen vascular action in a remarkable manner, especially in acute inflammation affecting the joints, the eye, or the serous membranes.

Opium is not only of use in the way that has just been indicated, but is of essential service in allaying the pain and irritability that often accompany inflammation, especially in many inflammatory affections of the bones and joints. In the form of Dover's powder, it is of especial value in this respect.

In the treatment of acute inflammation, it is of essential consequence that the patient should be kept at rest, in an atmosphere of well-regulated temperature, and on low diet; in fact, the more complete the abstinence in this respect, the more rapidly do therapeutic agents act and the febrile symptoms cease.

Local Treatment.—This is of the utmost importance, as it directly influences the tissues and vessels that are deranged in action. It consists of means of the most varied and opposite characters. Heat and cold; iced water and hot fomentations; astringents and sedatives—are all employed, and all with success, but each only in certain stages and forms of the disease; and the art in conducting the local treatment of inflammation consists in adapting the various means at our disposal to the particular condition of the case before us.

Local Blood-letting is the most efficient means we possess in directly lessening vascular action in part, as by it we take the blood directly from the inflamed and turgid vessels. It may be used in addition to, though it is now very commonly employed in preference to, general blood-letting, especially if the inflammation be not severe, or if it occur at either of the extremes of life, in women, and in persons generally of feeble power.

Blood may be taken locally by *punctures*, *scarifications*, or *incisions*, or by *leeching* or *cupping*.

Punctures and *incisions* can only be practised in inflammation of the cutaneous and exposed mucous surfaces, due attention being paid to subjacent parts of importance. They constitute a very efficient means of relieving the part, as not only is blood removed, but an exit is afforded for effused matters; tension is consequently materially lessened, and the tendency to sloughing and other evil after-effects perhaps prevented. The removal of the tension of inflamed parts is not only of the greatest advantage locally, but is of considerable service to the system at large by lessening the pain and general irritation that are always occasioned by it. The punctures should be made with a fine lancet, in parallel rows over the inflamed surface, and should not exceed a quarter of an inch in depth. The incisions must always be made in the axis of the limb, and should be so arranged as to afford the greatest possible relief to the tension. Their length and their depth must vary according to the seat of the inflammation. Thus in the inflamed conjunctiva they must of course be very limited, whilst in phlegmonous inflammation of a limb they may be of much greater extent and depth. Care must be taken as far as possible not to wound superficial arteries or veins. A modification of puncture is sometimes practised by opening the veins in the neighborhood of the inflamed part at several points at once. Thus, in inflammation of the testis the scrotal veins may be punctured with advantage. The bleeding from punctures and incisions should be encouraged by warm fomentations.

Leeches are usually applied to the neighborhood of inflamed parts,

but should not be put upon the inflamed surface itself, as their bites irritate. There are certain situations in which leeches should not be placed, as over a large subcutaneous vein, or in regions where there is much areolar tissue, as the scrotum or eyelids, lest troublesome hemorrhage or ecchymosis occur. So, also, they should not be applied near a specific ulcer, lest the bites become inoculated by the discharge. The bleeding from a leech-bite should be encouraged by warm poulticing or fomentations for some time after the animal has dropped off. In this way from half an ounce to an ounce of blood may be taken by each leech. There is usually no difficulty in arresting the hemorrhage from the bite; should there be any difficulty, continued pressure with some scraped lint, felt, matico, or powdered alum, will generally succeed. If this do not, which may happen in some situations where pressure cannot be conveniently applied, as on the neck and abdomen, particularly in young children, a piece of nitrate of silver scraped to a point, or a heated wire introduced into the bite, previously wiped dry, or a needle with a twisted suture over and around it, may be required.

Cupping is the most efficient means of removing blood locally that we possess, and the quantity extracted may be regulated to a nicety. It cannot, however, be employed upon the inflamed surface itself, on account of the pain and irritation that it would occasion, and is consequently chiefly applicable to internal inflammations. As the scars made by the scarificators continue through life, cupping should not be practised upon exposed surfaces.

Cutting off the Supply of Blood from the inflamed part by the ligature of the main artery leading to it has been adopted in some cases. Thus, in acute inflammation of a joint, the main artery of the limb has been tied; the femoral, for instance, in inflammation of the knee joint. By many Surgeons, and by most patients, the remedy would be considered far worse than the disease for the cure of which it is proposed.

Vanzetti has recommended digital pressure on the arteries in inflammation. He has, for instance, related a case of severe acute inflammation of the hand, relieved by twenty-four hours' continuous pressure on the brachial artery. Neudörfer speaks highly of the proceeding, which he regards as surpassing all others in efficacy, even rendering unnecessary the ordinary antiphlogistic treatment. He recommends intermittent pressure for not less than three and not more than eight minutes three or four times a day. The method is applicable to inflammation of any part of which the artery is within reach; and though we may not go so far with Neudörfer as to suppose that it obviates all necessity for constitutional treatment, it appears to be a remedy far preferable to local blood-letting.

In *Cold* and *Heat* we possess two most important local means of controlling inflammation. They cannot, however, be employed indiscriminately.

Cold.—There are two stages of inflammation in which cold may be employed with especial advantage: first, during the very early and acute stage, rather with a view of preventing or limiting the inflammation, so that it may not pass beyond the bounds of adhesive action; and next, when acute inflammation has passed off, the vessels of the part remaining relaxed and turgid: the application of cold being a powerful agent in restoring the tone of the parts.

Cold should never be had recourse to between these stages, when suppuration is coming on, or has set in; still less should it be employed when there is a tendency to mortification. Its long-continued and in-

cautious use may indeed be followed by profuse suppuration or extensive sloughing.

The modes of applying cold vary according to the part affected, and the stage of the inflammation. In the early and acute stage, and when the surface is inflamed, evaporating spirit lotions, to which sedatives may sometimes be advantageously added, are the best. If it be wished to influence the whole substance of a limb, irrigation with cold water should be employed (Fig. 69). If it be intended that the effect of the cold shall penetrate deeply, as in inflammations of joints, of the head, spine, or chest, pounded ice may be applied. The ice is best applied by being placed in a bladder, gut, or a Mackintosh bag, partially filled. Esmarch has especially pointed out the great advantage of using an India-rubber bag, which always remains dry, and from the use of which no danger from frost-bite is to be apprehended, as may occur from the long-continued use of cold and wet applications. With the view of removing the congestion remaining after inflammation, cold douching or sponging is most efficacious.

Warmth and moisture conjoined are of the utmost service in the treatment of inflammation during the height of that process—during that period when cold applications are not admissible. By these means, tension is relaxed, effusion is favored, and the over-distended vessels are relieved. If continued for too long a time, however, these means favor congestion, and sodden the parts. Warm applications are especially serviceable in all cases of inflammation attended by much pain, more particularly if this occur from tension; and they are especially useful when suppuration is threatening, or has come on, and in many cases where there is a tendency to slough.

When abscess threatens, or the surface is broken, nothing affords so much relief as a well-made *poultice*, either of linseed-meal or of bread; this, made soft and smooth, and not spread too thickly on the cloth containing it, should be applied as hot as the patient can bear it.

Water-dressing, consisting of double lint, well soaked in tepid water, and covered by oiled skin or thin gutta-percha, extending from half an inch to an inch beyond it on all sides, may be advantageously substituted for a poultice, if the sore be small, and the inflammation limited.

Fomentations of warm water, or of decoction of poppy and camomile flowers, applied by means of flannels wrung out of these liquids, or of bags containing the boiled plants, well soaked in the decoction, squeezed out, and applied hot, are very useful in extensive superficial inflammations. The flannels and bags should be well covered with oiled silk or Mackintosh cloth, so as to retain the heat, and to prevent evaporation. Spongio-piline may be used as a substitute for ordinary fomentations, in cases in which the surface is unbroken.

Belladonna applied externally exercises a very distinct and rapid controlling influence over superficial inflammation of an acute character. The extract, softened with water, and moistened with glycerine, may be painted on the inflamed part, or a strong solution of it added to the fomentations with greatest advantage.

Position and Rest.—The inflamed part should always be placed in such a position as to facilitate the return of blood from it. Unless this be done, the pain is greatly increased, and the congestion augmented. Hence the part requires to be elevated on a level with, or above, the rest of the body. All motion and use of the part must likewise be interdicted, as favoring determination and increasing pain.

These are the means by which acute active inflammation is arrested

and cured. In their employment, we must endeavor to proportion the activity of our measures to the age, constitution, and vigor of the patient, and to the seat and intensity of the local disease; and must continue the treatment until the inflammatory action is not only arrested, but has entirely subsided, and the part restored to its ordinary healthy state.

TREATMENT OF ACUTE INFLAMMATION WITH CONSTITUTIONAL SYMPTOMS OF THE ASTHENIC AND IRRITATIVE TYPES.—The *asthenic* and *irritative* forms of inflammation derive their peculiarities from the character of the constitutional disturbance, rather than from any peculiarity in the local affection. Hence it is in the management of the constitutional condition that the principal difference exists between the treatment of these and that of the other varieties of acute inflammation.

In considering this part of our subject, it is of especial importance to banish the term "*antiphlogistic;*" for the same treatment that would arrest inflammation in one form of the disease, would certainly favor its progress in another. Nothing appears to me to be more unscientific than to endeavor to treat all inflammations on one uniform plan. Surely the scoffers at medical science have some ground for doubting at least the wisdom of its Professors, when they see one set of practitioners treating every inflammatory disease with depletion, antimony, and calomel, whilst others teach that the panacea for all inflammations consists in brandy, ammonia, and bark. It is impossible that both methods can be right, as exclusive plans of treatment. But the error lies in making them exclusive. Each is serviceable in, and indeed only applicable to, its own particular cases. And between these extremes lie a multitude of forms of disease, in which endless modifications and combinations of these two methods of treatment—the stimulating and the depletory—must be adopted by the Surgeon in order to meet the varying conditions of his patient. The local symptoms that accompany the inflammatory process, whether occurring externally or internally, in the conjunctiva or in the lung, are associated with constitutional disturbance that varies according to the age and the constitutional condition of the patient. It is the type assumed by this constitutional disturbance, its sthenic or its adynamic character, as indicated by the pulse and by the tongue, and not the mere diagnosis of the local disease, that must guide the Surgeon in the adoption of his line of practice. We may advantageously treat with antimony and blood-letting acute inflammation of the conjunctiva, or that which is the consequence of a wound of the lung, in an otherwise healthy and robust man of thirty; whilst in a broken man of seventy, ammonia, bark, port wine and brandy would be equally proper; but if we were (except under peculiar and exceptional circumstances) to reverse this treatment—to stimulate the young or vigorous, and to deplete the aged or feeble—we should act contrary to common sense, and probably destroy rather than cure our patients. It is of far greater importance to be able to estimate accurately the true constitutional condition of the patient, than to be able to form a minute diagnosis of the precise seat, extent, and depth of the local mischief. It is a fatal error, too often committed, to attach the chief importance to the detection of the local malady, and to regard the recognition of the character of the accompanying constitutional disturbance as of minor interest. The Surgeon who acts thus runs the risk of treating the Name and not the Disease. If we treat erysipelas or pneumonia as mere affections of the skin or of the lung, on one uniform plan, without reference to the type of the constitutional disturbance accompanying them, we shall miserably err in a

large proportion of the cases. But if, paying but little heed to the local affection, except so far as its characters indicate the general type of the disease, we make the constitution of the patient our guide, and deplete or stimulate accordingly, even though we treat two patients with the same disease, so far as name is concerned, on totally opposite plans, we shall not act inconsistently, but in strict conformity with the natural condition of the patient and of his disease.

We must be guided in the means that we adopt entirely by the condition of the patient, the state of the tongue and pulse, and the general character of the symptoms. If these from the first partake of the asthenic or irritative type, we cannot at any period have recourse to the treatment that has been recommended in sthenic inflammation. If the disease commence in an active form, the fever progressively assuming a lower and lower character, merging into the asthenic and irritative types, so must we gradually modify the nature of our general treatment. This, however, is always a delicate procedure, requiring much caution. Though the inflammatory fever may at first assume the sthenic form, if there be reason to believe, from the broken constitution of the patient, or from the congestive or passive character of the local inflammation, that the constitutional symptoms will not long continue of this type, we must be extremely cautious how we lower the patient by active depletion; for, however high the fever may at first run (and in these cases there is often febrile disturbance of a very active character for the first few days), the disease speedily expends its force and rapidly subsides into a low form. In cases of this kind, which are of very common occurrence in London practice, more particularly in hospitals, we should never bleed, but content ourselves, after clearing out the bowels, with keeping the patient quiet on a moderately low diet, and administering diaphoretic salines. As the symptoms gradually merge into the typhoid type, the pulse increasing in frequency, but diminishing in power, the tongue becoming dry and dark, and the other symptoms of asthenia beginning to show themselves, we must begin to give some stimulant in combination with the salines. The carbonate of ammonia in five or ten grain doses, or even more, may be given with bark, or in an effervescent form with fifteen grains of the bicarbonate of potash and a sufficient quantity of citric acid, every third or fourth hour. The nourishment must be increased; and wine or alcoholic stimulants must be conjoined with it, in proportion as the symptoms of debility become more and more marked. In effecting this change, however, we must be careful not to run into the error of overstimulating our patient; this may be avoided by observing the influence exercised on the pulse and tongue by the change in treatment.

In the majority of cases, this stimulating plan is not well borne, during the first few days after the setting in of the inflammation, especially if there be gastric irritation and sickness; but when the more active symptoms show a tendency to subside, when the bowels have been well cleared out, and the skin is beginning to assume a slight degree of moisture, then it may be resorted to with every probability of success.

In many cases, however, it happens that the symptoms so rapidly sink into an asthenic character, or from the very first assume it, that the only treatment which holds out a prospect of saving the patient's life consists in the early and free administration of tonics and stimulants, with mild nourishment, such as ammonia and bark, wine, brandy, or porter, with beef-tea and arrowroot; and of these, large quantities may be required in the four-and-twenty hours, the patient evincing a tendency to sink

whenever their use is interrupted. Although stimulants be freely administered in these cases, the food should be bland and capable of easy assimilation. It is worse than useless to give meat, &c., when the patient cannot digest it; but beef-tea, eggs, and farinaceous food, may be given in large quantities with advantage. The brandy-and-egg mixture of the Pharmacopœia, if well made, combining nutriment and stimulus, is the best remedy that can be administered in many cases of low inflammation.

Under this plan of treatment the tongue will be found to become moist, the brown sordes to clear off from the inside of the mouth, the pulse to become steady and full, sleep to be procured, and the strength maintained. The more I see of surgical inflammation, the more confidence do I feel in this stimulating plan of treatment, which is the only method of carrying patients through those low forms of visceral inflammation that are so frequent in hospital practice. The liability to these inflammations will also be materially lessened by the early employment of a stimulating plan of treatment after injuries and operations.

As the asthenic passes into the irritative form, we may find it necessary to combine opiates with the general treatment.

In the low forms of inflammatory fever, congestive pneumonia and asthenic bronchitis frequently supervene. In this complication, the following draught may be advantageously given every third or fourth hour:—℞. Tincturæ Camphoræ comp. ♏xx. ad xxx., Ammoniæ Carbonatis gr. v. ad x., Decocti Senegæ ℥iss. Rubefacients, blisters, or dry cupping may also be applied to the chest The diarrhœa that not unfrequently occurs must be met with opiates and astringents; and if the urine cannot be passed, it must be drawn off by the catheter.

CHRONIC INFLAMMATION.

The preceding description is principally applicable to acute inflammation; and it now remains to give a brief summary of the distinctive characters of the chronic form of the disease, and to describe its treatment.

Pathology.—In acute inflammation, the changes that take place in the vessels and the blood are strongly marked and more or less rapid in occurrence; and the modifications of nutrition which the part undergoes are mostly of a temporary character, and hold a secondary relation in point of importance to the other conditions. In chronic inflammation, on the other hand, the changes in the nutrition of the part form the principal feature. Billroth, in describing chronic inflammation, says: "The distension of the capillary vessels, or fluxion, is a less prominent symptom, while the new formation of tissue and serous infiltration seem to play a more prominent rôle. The cell-infiltration of the tissue takes place in few cases, as it does in acute inflammation; but the individual cells often attain a rather more complete development. In this process of development the intercellular tissue changes; the connective tissue filaments lose their tough filamentary consistency, the distensibility and elasticity of the subcutaneous tissue are impaired, and the consequence, as regards the coarser palpable and visible consequences, is that the tissue becomes more swollen and fatty, and less moveable than normal. This is the first stage of every chronic inflammation."

Phenomena.—Regarding the modifications of color, size, sensation, function and temperature, described as attendant on acute inflammation, it is to be observed that they are also present in chronic inflammation; differing, however, in origin and in degree, and often in order and com-

bination. The *color* is not always changed, unless the part affected be very superficial; and the redness is rather of the dull than of the bright hue, not depending on the rapid transmission of an increased quantity of bright blood, but rather on a congestive condition. The affected tissue may become permanently discolored, probably by the escape of large numbers of red blood-corpuscles through the walls of the vessels, and the retention of their coloring matter after the removal of the more fluid parts of the effusion. The *pain* is less frequently of the spontaneously acute character, but partakes more often of the character of tenderness, being elicited only by pressure: sometimes, however, the pain is very severe. The increase of *temperature* is but slight.

Swelling is an early and most important sign in chronic inflammation. It depends less on the enlargement of the vessels than on the effusion which takes place, and the nutritive changes which may be said to constitute the distinctive characteristic of the disease. The effused material consists partly of serum and partly of plastic matter. The former may become absorbed; or, in the case of serous membranes, it may remain distending the cavities which they line, as in the joints. The plastic matter is more liable to remain, and to lead to hypertrophy, or thickening and induration of the part.

Like acute inflammation, the chronic form of the disease may be attended with *suppuration*. This will be described in the next chapter. (Pages 160—165.)

In chronic inflammation of mucous or serous membranes, there may be an increase with modification of the *secretions;* producing, in the case of the mucous membranes, the condition known as chronic catarrh.

Constitutional Symptoms.—These are less marked in chronic than in acute inflammation; but if the disease assume an acute character, one of the forms of inflammatory fever already described may appear. The patient's health, however, is in most cases impaired; being, in many instances, affected with some constitutional taint which has had its influence in producing or maintaining the chronic character of the inflammation. If an important organ be affected, or if the chronic inflammation, though affecting parts not essential to life, be very extensive, the pulse will be found to be habitually above the normal standard, and exacerbations of fever, often of a distinctly periodic character, develop themselves.

Causes.—Chronic inflammation may arise from the presence of some local irritation, which, if temporary, would produce acute inflammation only, but, by its permanence, produces the continuance of the diseased condition. It is specially liable to occur in some constitutions, as the scrofulous; indeed, certain forms of chronic inflammation, especially of the glands and joints, are very common in scrofulous subjects.

Treatment.—The treatment of chronic inflammation is far more difficult, and requires much more attention, than that of the acute form of the disease. Chronic inflammation is so frequently complicated with various unhealthy conditions of the system, and with an impaired state of the general health, by which, indeed, it is often kept up, that much practical tact and skill are required in carrying out the therapeutic indications properly.

Constitutional Treatment of Chronic Inflammation.—In the treatment of chronic inflammation we have not so much to subdue inflammatory action, as to remove structural changes and other effects induced by it. Hence, our object is not to produce a great and sudden impression on the system, as we are often required to do in the treatment of the acute affection. It is not in this way that chronic inflammation can

ever be cured, or its effects removed. The patient might be bled almost to death, and still the diseased action would go on in the inflamed part. It is true that the same antiphlogistic means are employed in arresting the chronic as in cutting short the acute form of the disease, but they are used in a less energetic manner; our object being to induce a gradual and continuous improvement in the state of the system and of the diseased part. Local nutrition is always deeply modified in chronic inflammation; and it can only be restored to its normal condition by improving the patient's general health, as well as by producing an impression on the part itself by appropriate topical means. Hence, in the treatment of chronic inflammation, hygienic measures are of the first consequence. In most cases, nothing can be done without proper attention to these; and much can be done by these that cannot be effected by any more direct medicinal means. The treatment of this form of inflammation must likewise be varied according as it is uncomplicated, occurring in an otherwise healthy constitution, and assuming a sthenic type; or as it occurs in a cachectic and feeble system, assuming a congestive or passive character; or as it is met with in an unhealthy constitution, affecting a specific form.

In the management of these various forms of chronic inflammation the patient must be kept at rest, and, if the disease be at all extensive, confined to bed. He should be in pure air, and as a general rule, have a light and unstimulating diet. The regulation of the **diet** is of much consequence, and the amount and quality of the nourishment afforded must be carefully proportioned to the age, strength, and previous habits of the patient, as well as to the degree and the seat of the inflammation, and the form of constitutional fever that accompanies it. In the more active form of chronic inflammation, farinaceous slops, at most beef-tea, and light puddings, can alone be allowed. In the less active forms occurring in feeble constitutions, with depression of general power, animal food of a light kind may be given, and the scale of nourishment increased until stimulants, as beer, wine, or brandy, are allowed. Nothing requires greater nicety in practice than to proportion the diet, and to determine the cases in which stimulants are necessary. It may be stated generally that, the more the disease assumes the asthenic and passive forms, the more are stimulants required; until, at last, in the truly adynamic type, our principal trust is in these agents, and large quantities of wine, brandy, and ammonia are required to maintain life.

Mercury is of essential service in the more active forms of chronic inflammation; but in all cachectic and strumous constitutions it should, as much as possible, be avoided. It is of great use not only in arresting the further progress of the disease, but especially in causing the absorption of the effusions, and in removing some of the other effects of chronic inflammation, such as thickening, hardening, and opacity of the parts. It should be given in small doses for a considerable length of time, until the gums are slightly affected. In many cases of depressed power it may be very advantageously conjoined with bark or sarsaparilla. The most useful preparations are calomel in half grain or grain doses, and the iodide of mercury in the same quantities; or, if a gradual and continuous effect be required, the perchloride in doses from one-sixteenth to one-eighth of a grain.

Iodide of potassium is an alterative and absorbent of the greatest value, especially in the chronic inflammations of fibrous or osseous tissues, or of the glands, occurring in strumous constitutions. In these it may often be substituted with great advantage for mercury, and given

in those cases in which that mineral would otherwise be administered. In many cases it is of essential service after a mercurial course; some days should, however, be allowed to elapse after the mercury is discontinued before the iodide is given, otherwise profuse salivation or even sloughing of the gums may result.

Sarsaparilla is a very valuable remedy if obtained good, and forms an admirable vehicle for the preparations of mercury or iodine. The fluid extract of red Jamaica sarsaparilla, carefully prepared, is that to which I give the preference; and where the inflammation is associated with want of power, its value is certainly very great.

Cod-liver oil is of the very greatest value in the various strumous forms of chronic inflammation in debilitated, emaciated, and cachectic subjects. It may be given in some vehicle, such as milk, orange-wine or juice, that covers its taste. In some cases it is advantageously conjoined with the iodide of potassium, or, where there is much want of power, and strumous anæmia is present, with the preparations of iron. It is more particularly in children and young people that it is of service in removing the various effects of chronic inflammation.

Purgatives are often required in chronic inflammation. In robust subjects in whom the disease is active, salines may be employed; to which, if there be a rheumatic tendency, colchicum may advantageously be added. As a general rule, warm aperients, such as the compound decoction of aloes, with Rochelle salt, answers best; and in children a powder composed of one part of mercury and chalk, two of carbonate of soda, and four of rhubarb, will be found very serviceable.

Local Treatment of Chronic Inflammation.—In chronic inflammation, our local means of treatment are much more varied than in the acute form of the disease.

Local Blood-letting is often required with a view of directly unloading the vessels of the part; and this is accomplished by scarification, leeching, or cupping. Scarification is principally employed in chronic inflammation of the mucous membranes. Leeches may very usefully be employed, in some forms of chronic inflammation, by applying two or three at a time, and repeating this application every second or third day.

Warmth and Moisture are not so serviceable in chronic as in acute inflammation, and care should be taken that they be not continued for so long a time as to sodden the parts. An astringent or stimulant, such as liquor plumbi or spirits of wine, may often advantageously be added to the warm application.

Cold is seldom required in any but the advanced stages of chronic inflammation, in which there are debility and passive congestion of the vessels of the part. In order to remove this state of things, its application should not be continuous, but should be made twice or thrice a day, so as to occasion a sudden shock, and produce a constringent effect upon the enfeebled vessels of the part. This is best done by pumping or pouring cold water from a height, or by douching, and should be followed by active friction with the hands.

Friction is often of great service in some of the forms of congestive inflammation, by the removal of the thickening, stiffening, and induration that result. Friction may be practised either with the naked hand, or with some embrocation of a stimulating or absorbent character.

Counter-irritants are amongst the most energetic local means that we possess for combating chronic inflammation. Rubefacients, in the shape of stimulating embrocations, to which absorbents, such as mercu-

rial ointment, may often advantageously be added, are usefully employed as adjuncts to friction.

By means of *blisters* applied either directly over the inflamed part, or at a little distance from it, the surface being kept raw and exuding by some stimulating application, effusions and those chronic structural changes that accompany the more advanced stages of inflammation may be removed.

In the latter stages of chronic inflammation, the *pyogenic counter-irritants*—issues, setons, and the cautery—may be very advantageously employed. By these a powerful derivative action is induced, and chronic thickening may be melted away.

Issues are of especial service in chronic inflammation of the viscera, joints, and bones, before suppuration has taken place. They should be applied in the soft parts over the affected structures, and may be kept open for a very considerable length of time. They are best made in the following manner. A piece of common adhesive plaster, about two inches square, having a hole of the size of a shilling cut in its middle, is fixed upon the part where the issue is to be made; a piece of potassa fusa, about the size of half a cherry-stone, is then placed on the surface left uncovered by the circular central aperture, a square piece of plaster being laid over all. The patient experiences a burning pain for about two hours, when it ceases; on removing the plasters, a black slough, corresponding in size to the central aperture, will be found. This must be poulticed for a few days, until it separates, and the raw surface then dressed with savine ointment, or stimulated by an issue-bead. Whenever it shows a tendency to heal, it may be kept open by an occasional application of the potassa fusa.

A Seton is more useful than an issue when counter-irritation is to be applied over very deep-seated parts. The seton may most conveniently be made in the following way (Fig. 70). A fold of skin about two inches

Fig. 70.—Introduction of a Seton.

or more in breadth is pinched up, and its base transfixed by a narrow-bladed bistoury. The blunt end of an eyed probe, threaded with the seton, is next pushed along the back of the blade from heel to point, which being withdrawn as the probe is carried onwards, the seton is left in the wound. A poultice should then be applied.

The **Actual Cautery** is especially successful in deep-seated chronic inflammation, as of joints, when a deep and prolonged action is required to be set up. The cauterising irons may be of various shapes. They should be heated to a dull red heat, and then quickly drawn in lines, crossing one another, over the part.

Astringents directly applied to the inflamed parts are of extreme

service in those forms of congestive or passive inflammation in which the circulation is sluggish and the capillaries loaded; they afford relief in these cases by inducing contraction of the vessels. In order to ensure their proper action, they must be employed of sufficient strength; for if too weak they irritate, and increase rather than relieve the congested condition. The nitrate of silver is the astringent that is commonly preferred; and this, applied either solid, or in solution containing from ten grains to one drachm of the salt in one ounce of distilled water, will produce a very marked beneficial influence in congestive inflammation of the mucous and cutaneous surfaces.

Pressure by means of well-applied bandages, elastic webbing, or strapping, is of essential service in supporting the feeble vessels in congestive inflammations. In many cases pressure may be advantageously conjoined with absorbents and rubefacients, as mercurial and camphor liniments, or the plaster of mercury and ammoniacum. This treatment, by removing congestion, and promoting the absorption of inflammatory effusion, is especially useful in chronic forms of inflammation accompanied by thickening of parts, as in the joints and testes.

CHAPTER V.

SUPPURATION AND ABSCESS.

SUPPURATION, or the formation of pus, has already been referred to in the last chapter, as one of the results of inflammation. It consists, in fact, as will be presently described, of a continuance and exaggeration of one of the factors of inflammation—the excessive formation of white cells.

CHARACTERS OF PUS.—Pus presents considerable variety in its general character, according to the nature of the patient's constitution, or the condition of the part in which it is formed.

When formed in a person of healthy constitution, as the result of sthenic inflammation, it is an opaque, creamy fluid, thick, smooth, and slightly glutinous to the touch; of a yellowish-white color, with a greenish tinge, having a faint odor, and an alkaline reaction. Its specific gravity is from 1030 to 1033. Chemically, it contains various albuminous compounds, with fatty matters, and salts, chiefly chloride of sodium: it usually gives off a small quantity of ammonia. Pus presenting these characters is termed *healthy* or *laudable*.

When admixed and tinged with blood, pus is said to be *sanious;* when thin, watery, and acrid, *ichorous;* when containing cheesy-looking flakes, it is termed *curdy;* and when diluted with mucus or serum, it is frequently called *muco-pus*, or *sero-pus*. Besides these, pus presents many other varieties. Thus, for instance, when formed from bone, or in the neighborhood of the alimentary canal, it has a peculiar fetid odor. Its chemical composition may likewise vary under different circumstances: thus, ordinary pus formed in the soft parts contains merely a trace of phosphate of lime, whereas that which is formed in connection with diseased bone has been found by B. Cooper to contain $2\frac{1}{2}$ per cent. of this salt. Pus presents other peculiarities, which are only cognisable by their effects on the system: thus, the pus from specific sores pos-

sesses contagious properties, though in chemical, microscopical, and physical constitution, it does not differ from other forms of that fluid.

Microscopic Characters.—On examining pus under the microscope, it is found to consist of corpuscles floating in a homogeneous fluid, the "liquor puris." These corpuscles, about $\frac{1}{2500}$ to $\frac{1}{3000}$ of an inch in diameter, are composed of a semi-transparent cell-wall, containing two or three nuclei, which are rendered very apparent by acetic acid (Fig. 71). The appearance here described, however, is that of the corpuscles in the dead state, after removal from the body, and when their temperature has fallen. The researches of Von Recklinghausen, Schultze, and others, have shown that these corpuscles (and the white corpuscles of the blood) undergo changes of form like those of the amœba. When examined under favorable circumstances, they are seen to shoot out projections, and to withdraw them; and it has also been found that, like the amœba, they have the power of incorporating into their substance matters, such as pigments, with which they come into contact. Besides these corpuscles, granular matter, particles of fibrine, and disintegrated cells, are usually found admixed in greater or less amount. The greater the quantity of corpuscles, the richer and more creamy is the pus.

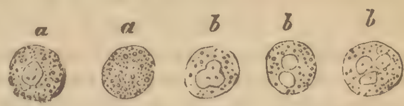


Fig. 71.—*a*. Healthy Pus-cells. *b*. Treated with Acetic Acid. Magnified 800 Diameters.

In many cases, however, the microscopical characters of pus differ from those that have just been given. Thus, in the thin, greasy, yellowish-looking pus, somewhat resembling melted butter, which we find in the joints in pyæmia, the pus-corpuscles are irregular in outline, and not so distinctly nucleated (Fig. 72); and in some forms of chronic abscess, when the pus is thin and curdy, the pus-corpuscles present a somewhat similar appearance, undergoing fatty degeneration (Fig. 73).

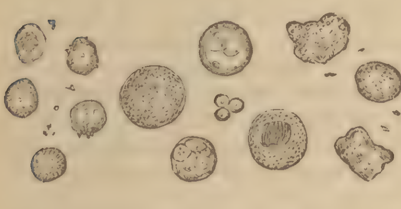


Fig. 72.—Pus-cells from Pyæmic Abscess.

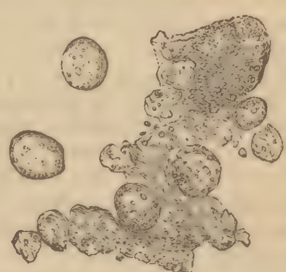


Fig. 73.—Pus-cells from Scrofulous Abscess.

Diagnosis.—The diagnosis of pus is usually easy, but some fluids resemble pus so closely to the naked eye, that the microscope is necessary to establish their characters. From *healthy mucus* there is no difficulty in distinguishing pus; but when mucus has been thickened and rendered opaque by inflammation and is mixed with exudation-cells, it is impossible, and can never be necessary to distinguish it from pus. *Turbid serum*, containing broken-down and granular fibrine, frequently met with in serous sacs, and *softened fibrine*, as in clots and inflamed vessels, are distinguished from pus by the absence of pus-cells. *Atheroma* is recognized by the presence of cholesterine-scales and fat, and by the non-existence of the characteristic pus-corpuscle. In *tubercle* and *cancer* the

absence of the true pus-cell, and the presence of appearances characteristic of these morbid products, establish the diagnosis. When it is admixed with *blood*, the detection of pus is often very difficult, and indeed, cannot in many cases be satisfactorily accomplished, on account of the close resemblance between the white corpuscles and its cells. When pus is diffused in *milk*, as in some forms of lacteal abscess, the corpuscles of this fluid will be seen to be smaller and clearer, with a more defined outline than those of pus.

PYOGENESIS, or the FORMATION OF PUS, is an interesting study. The older Surgeons believed that this fluid was formed by the breaking up or disintegraton of the solid tissues, or that it was the result of their liquefaction or saponification by the fluid products of inflammation. Hewson and Hunter exposed the fallacy of these opinions; and modern pathologists look upon pus as a direct product of inflammation. When suppuration takes place, there is indeed a breaking up of the tissues; but it is not their mere *débris* which constitutes pus.

The close resemblance between the white blood-corpuscles and those of pus was pointed out as long ago as 1842, by Dr. W. Addison, and subsequently by Dr. A. Waller, but their observations seem to have been almost forgotten until about eight years ago, since which time an interesting investigation has been carried on by several observers, as to the source of the pus-corpuscles, and the manner in which their numbers become increased. The researches on this point have an intimate connection with those to which reference was made in the previous chapter, on the behavior of the white corpuscles of the blood in inflammation.

The mode of formation of pus has been examined by Cohnheim, Hoffmann, and Von Recklinghausen, in the cornea of the frog—a non-vascular tissue. On injuring the cornea, there follows in two or three days a yellowish opacity, due to pus-corpuscles, and commencing always, according to Cohnheim, at the periphery, even when the lesion is central. The pus, it is hence inferred, cannot have been formed in the cornea, but must have come from without; but from what source? It had been shown that finely divided coloring matter, when brought into contact with cells, such as those of pus, is taken up and retained by them. Accordingly Cohnheim introduced aniline blue, and Hoffmann and Von Recklinghausen cinnabar into the blood; and, on afterwards examining the pus, found it colored by these substances, which had been taken up by its corpuscles. On introducing the same substances into the anterior chamber of the eye, and the injured cornea, no such effect was produced. Hence the inference was, that at least many of the pus-cells come from the blood.

It is still a debated question, whether all, or even the majority, of the pus-corpuscles are to be accounted for by migration of white cells or leucocytes, as they have been called, through the walls of the blood-vessels. That this is the source of most of them, was the view held by Cohnheim, who regarded the blood-forming organs—the spleen and lymphatic glands—as their ultimate source. Others, however, including Billroth, Hoffmann, and Von Recklinghausen, consider that a large proportion of the pus-cells must be formed in the tissues outside the vessels, especially in the corpuscles of the connective tissue. This view is that which appears to be most generally received. Burdon Sanderson remarks that "in every limited inflammation of the subcutaneous tissue, and in the neighborhood of every subcutaneous abscess, a region is found outside of the focus of suppuration, in which the connective tissue corpuscles present alterations which are so distinct, that it is impossible for

any one who is conversant with them to doubt that they signify that the tissue is germinating.

Relation of Suppuration to other Changes in the Tissues.—The essential characteristic of suppuration is, as has been shown, the development in excessive number of corpuscles closely resembling, if not indeed identical with, the colorless corpuscles of the blood. It is dependent on inflammation, although in some cases, such as the "cold abscess" to be hereafter described, the other phenomena of inflammation may be very slightly marked; and it therefore is found to occur along with the other tissue changes, whether of repair or of destruction, which are connected with inflammation.

The process of repair of injuries, as will be described hereafter, is attended in general by more or less of inflammation, under which a supply of organisable fibrinous matter or lymph is thrown out, and undergoes conversion into cicatricial tissue. Very frequently—especially under exposure to the air—suppuration takes place at the same time. In an ordinarily healthy subject, this plastic or adhesive inflammation gradually gains ground, and, overcoming the tendency to suppuration, closes the wound. In such cases the pus, so long as it is formed, is of the "healthy" or "laudable" kind. And though the suppuration is by no means essential to the process of repair, still the presence of pus of this kind indicates a healthy condition of the system and of the part.

In other cases, especially in cachectic or specifically diseased states of the system, the material effused from the blood-vessels is deficient in plastic property, neither repairing the wound nor forming "laudable" pus; but consisting of thin serous fluid containing corpuscles. This will be again referred to in Chapter VII., in describing the process of "Union by Adhesive Inflammation."

Circumstances influencing the Tendency to Suppuration.—Why do the adhesive or fibrinous products of inflammation preponderate in some cases, and the suppurative or corpuscular in others? This question has been closely investigated by Hunter, Bichat, Rokitansky, and C. J. B. Williams, and has been very clearly answered by Sir James Paget, who has pointed out that the difference is dependent on three causes:—1. The state of the blood; 2. The seat of the inflammation; 3. The degree and character of the inflammation.

1. **State of the Blood.**—Paget applied blisters to thirty different patients, and collected the sero-fibrinous fluid that accumulated in the blebs. In those who were suffering from purely local diseases, the constitution being otherwise healthy, the fluid was firm, filamentous, and elastic; in cachectic or phthisical patients it was almost wholly corpuscular; with every intermediate variety, according to the condition of the system. As a general rule, in young persons and in those of sound constitution, the fibrine is plastic; hence it is in these individuals that we may chiefly look for the union of wounds by adhesive inflammation. In scrofulous constitutions, on the other hand, the inflammation that is excited by a trivial injury, as the sprain of a joint for instance, is very apt to run on to suppuration. So again, in certain cachectic states of the system, slight wounds suppurate, or fester as it is termed.

2. The **Seat** of inflammation modifies its product very considerably, as Bichat and Hunter long ago pointed out. Serous membranes are prone to fibrinous, the mucous to suppurative inflammation; and in areolar tissue, both fibrine and corpuscles are found. This general rule, however, is subservient to the state of the constitution, and to the in-

fluence of certain specific diseases. Thus in diphtheria and croup, lymph is poured out on the mucous membrane of the throat; whilst, in empyema, pus is formed in the cavity of the pleura.

3. The **Degree** and **Character** of the inflammation modify considerably the product. When the inflammation is of an active sthenic character in a healthy constitution, it requires considerable intensity to give rise to suppuration. It is only where the system is strongly predisposed by struma or cachexy, that very slight inflammations terminate in this way. The degree of inflammation required for the formation of pus varies greatly, but it is always greater than that necessary for plastic exudation. Certain *forms* of inflammation are always attended by specific products. In pyæmia, for instance, all the products have a suppurative tendency, even when serous membranes are inflamed. In croup, on the other hand, there is a disposition to plastic effusion even on mucous surfaces. The specific character of the inflammation often determines the supervention of suppuration: some diseases, such as gonorrhœa and ophthalmia, consisting essentially in the secretion of pus by a free surface.

4. In addition to the conditions above mentioned, the **Local Condition of the Part** influences the probability of suppuration. Thus a subcutaneous wound, as in tenotomy, does not suppurate; but if it be opened, and its interior exposed to the air, then suppuration takes place. For the same reason all ulcers suppurate. The lodgment of foreign bodies, as of urine, a piece of bone, or a bullet, by exciting intense and continuous inflammation, almost inevitably leads to suppuration, which is indeed the means adopted by nature for their removal from the system.

The DURATION of suppuration varies greatly. Inflammation very commonly terminates in the formation of pus, in the course of about three days; at other times a much longer period than this is required, the inflammatory action being passive and languid. When once suppuration has been set up, it may continue for an indefinite time; the formation of pus-cells becoming, as it were, the established condition of the part. It is not uncommon to find purulent discharges from mucous membranes continuing for years.

SYMPTOMS OF SUPPURATION.—These are local and constitutional.

The **Local Symptoms** differ as the suppuration occurs on a mucous surface, or in the interior of a tissue or organ.

When an inflamed *mucous surface* is about to suppurate, the membrane presents the ordinary characters of active inflammation, being hot, swollen, red, and often painful; to these a discharge is speedily superadded.

When suppuration is about to take place in *the substance of tissues or organs*, so as to give rise to an abscess in one of the forms to be presently described, the local symptoms of inflammation undergo certain modifications indicative of the supervention of this action. The pain becomes throbbing; the part swells and becomes tense, but after a time softens, and fluctuation or undulation may be detected in it. The skin becomes glazed, red, shiny, and œdematous. In other cases, again, suppuration occurs without any evident sign of local inflammation, the presence of the pus revealing itself by swelling and fluctuation only.

Constitutional Symptoms.—On the supervention of extensive suppuration the ordinary symptoms of inflammation subside, and are usually interrupted by the occurrence of chills, alternation of heat and

cold, or, if the formation of pus be extensive, by severe and long-continued rigors. The fever often assumes a somewhat intermittent character, and its intensity lessens, the pulse becoming soft, though quick. The temperature is habitually above normal and rises considerably, perhaps up to 104° F., with tolerable regularity at one period of the day, and especially during the occurrence of rigors. If pus be formed in sufficient quantity for its discharge to act as a severe drain on the constitution, other symptoms set in, dependent on the loss that is going on. The patient becomes weak, the nutrition is impaired, and *hectic* is established.

Hectic does not come on unless there be a discharge of pus from the system. No hectic occurs so long as an abscess, however large, continues unopened; but it may supervene with great rapidity when once its contents are discharged. I have known large abscesses to exist unopened for several years, without any constitutional disturbance; but, as soon as they were opened, well-marked hectic set in, which speedily carried off the patient.

Hectic is essentially a fever of debility, conjoined with irritation. Emaciation and general loss of power invariably accompany it. The pulse, which is quick, small, and incompressible, rises from ten to twenty beats above its normal standard; the tongue becomes red at the edges and tip; the cheeks are often flushed, and the eyes glistening, with dilated pupils; all these symptoms have a tendency to exacerbations after meals and towards evening. There is also increased action, either of the skin, bowels, or kidneys. Thus, profuse sweating, copious purging, and abundant deposits of lithates in the urine take place; these discharges often alternate with one another, as it were, melting the patient away, and hence are termed *colliquative*. The debility gradually increasing, the patient rapidly wastes, and at last dies from sheer exhaustion, the conjoined result of fever, malnutrition, and wasting discharges.

In some cases of extensive suppuration, especially in children, hectic does not occur, but marasmus or atrophy takes place with amyloid degeneration of the viscera, more especially the liver, the child wasting away without fever, and being carried off at last by exhaustion or some intercurrent disease.

ABSCESS.

Suppuration may occur on the mucous or serous surfaces, or on the surfaces of ulcers or wounds, constituting *Purulent Secretion* or *Exudation;* or pus may be collected in the interior of a tissue of an organ, forming an *Abscess.*

An **Abscess** signifies a collection of pus occurring in any of the tissues or organs of the body. In structure, an abscess consists of an accumulation of pus situated in the midst of, and surrounded on all sides by, a layer of fibrine deposited in and consolidating the neighboring tissues. This lymph, which constitutes the *wall* of the abscess, varies greatly in thickness and consistence; in some cases being scarcely perceptible, in others some lines in thickness and of corresponding firmness, constituting perhaps the principal part of the mass. This wall of "limiting fibrine" is very vascular, in consequence of the inflammation and congestion of the tissues that enter into its composition. Surgeons divide abscesses into various kinds, according to the symptoms attending them, their duration, and their cause. Thus they speak of Acute and Chronic, Hot and Cold, Lymphatic, Diffuse, Metastatic, Pyæmic, and Puerperal Abscesses.

Acute or Phlegmonous Abscess may be taken as the type of the disease. When it is about to form, the part which has been previously inflamed swells considerably, with a throbbing pulsatile pain; the skin becomes shining, glazed, and of a somewhat purplish red. If the abscess be very deeply seated, the superimposed tissues become brawny and œdematous, without, perhaps, any other sign indicating the existence of pus. As the swelling approaches the surface, it softens at one part, where fluctuation becomes perceptible, and a bulging of the skin covering its summit takes place: this *pointing of the abscess* indicates that it is about to burst and discharge its contents, which it speedily will through a circular aperture formed in the skin.

The intimate pathological phenomena attending the formation of an abscess are as follows. In the inflamed part, a collection of white cells takes place in the areolar tissue and gradually increases; meanwhile, the proper tissue of the part is broken down and removed, or its shreds may remain mixed with the pus. The tissue lying beyond this collection of pus is very vascular, and is infiltrated with new plastic matter, which, in healthy states of the system, forms a layer of "limiting fibrine" or "limiting membrane."

An abscess, perhaps originally deeply formed in the substance of a limb, increases by the additions of cells from the blood-vessels of the limiting membrane, and also probably from the action of the already existing amœboid cells in the tissues with which they come into contact. As the abscess extends, it has a special tendency to approach a free surface, whether that be external or internal, skin or mucous membrane; the tissues between it and the surface towards which it is progressing being gradually broken down, at the same time that the formation of cells is increased by the continuance of the inflammatory process in this direction. It is in this that the *pointing* essentially consists. As the abscess approaches the surface, the skin at first becomes more or less livid, tense, and œdematous, indicating the interference with its circulation; as the summit of the abscess presses upwards, the overlying skin loses its tension and becomes relaxed; it then sloughs at the most central point, from which the cuticle has previously peeled off, and, the outward pressure of the pus speedily detaching the slough, the abscess discharges itself. Though acute abscesses, if left to themselves, usually run this course and burst through the skin, the mucous or serous surfaces, or even into the interior of joints, yet some collections of pus, if very deeply seated, cannot find their way to the surface, but extend through the areolar planes of the limb in a lateral direction, burrowing and undermining the parts to a great extent; or, if situated in dense and unyielding structures, as in bone, are imprisoned within a case through which they may be unable to penetrate; in other rare instances, the pus becomes absorbed, and the abscess disappears. After an abscess has burst or has been evacuated, its walls, which have a close resemblance to a granulating surface, contract and become corrugated, and gradually close the cavity; in some cases, however, the cavity does not completely close, but contracts into a narrow canal, forming a sinus or fistula (p. 178).

Diffuse Abscess forms rapidly in the areolar tissue, as the result of diffuse inflammation. There is no limiting fibrine, and hence the pus often spreads widely, producing extensive destruction of parts before it is discovered. A particular variety of this form of abscess is the *Puerperal*, occurring in women after parturition in various parts of the body, especially in the iliac fossa, in the areolar planes of the thigh

or in the joints, and in the adipose tissue of the orbit, often destroying the globe of the eye. To these forms of the disease the **Metastatic Abscesses** are closely allied. They commonly occur as consequences of pyæmia, are very numerous, and are met with in the substance of organs as well as in the areolar tissue and joints. The last three species of abscess are varieties of the acute form.

Chronic Abscesses are of very common occurrence. The tissue in the vicinity of a piece of dead bone being irritated by its presence, or a gland or some portion of the subcutaneous areolar tissue having become indurated, tender, or subacutely inflamed, at last, slowly and without any constitutional symptoms, or much appearance of local disturbance except the swelling, softens and breaks down into a somewhat thin, flaky, curdy, puriform fluid, though in some instances the pus is perfectly healthy. These abscesses do not readily point, but often extend laterally, burrowing for a considerable distance from their original seat, In other cases they become circumscribed by a thick and dense wall of fibrine, through which it may be extremely difficult, and perhaps impossible, to detect fluctuation; the disease then simulating a solid tumor. The duration of these chronic abscesses without opening is often very remarkable, even when situated in soft parts: I have seen large chronic abscesses, in the iliac fossa and groin, perfectly stationary for nearly two years. When situated in denser structures, as in the substance of the breast, the wall may become so dense as to resemble a cyst, and the disease will continue in the same state for a great length of time. In the bones, abscesses may exist for an indefinite period.

Cold, Lymphatic or **Congestive Abscess** often occurs with but slight precursory local symptoms, or even without any at all. The patient, who has usually been cachectic, and has suffered some time from general debility, feels slight uneasiness in the groin, iliac fossa, or axilla, and finds suddenly a large fluctuating tumor in one of these situations: there is perhaps no pain in the part, and no discoloration of the skin, but the fluctuation is always very distinct, the limiting fibrine being in small quantity. On opening such an abscess as this, there will usually be a copious discharge of thin unhealthy pus, which, when examined under the microscope, will be found to contain ill-developed, withered cells; in some cases, the contents appear to be a clear semi-transparent or oily-looking matter, probably sero-plastic effusion.

Tympanitic or **Emphysematous Abscess**, which contains gas as well as pus, is occasionally met with in the neighborhood of the mucous canals, chiefly at the anterior and lateral parts of the abdominal walls, and about the sacrum. Sometimes the communication with the intestine is very free; in other cases it is not so evident. These collections are often perfectly resonant on percussion, the air being above, the fluid below; and sometimes gurgling is very distinct in them.

Situation, Size, &c.—Abscesses are met with in all *regions* of the body, but more especially where the areolar tissue is abundant, and the absorbent glands are numerous. They may occur at any *period of life*, from the earliest infancy to old age. I have opened a very large abscess in the axilla of a child about a fortnight old. Their *size* varies from that of a pin's point to a tumor containing a pint or more of pus. In some cases, when very large, they are *multilocular*, the different cysts being connected by narrow channels of communication: in this way I have seen a large abscess extending from the lumbar vertebræ through the iliac fossa down the thigh, the ham, and the leg, until at last it was opened by the side of the tendo Achillis, forming five or six


Fig. 74.—Large Psoas Abscess extending down the Thigh and Leg.

distinct cysts, communicating with one another by contracted channels (Fig. 74).

Effects.—The *pressure-effects* of an abscess are often important. By pressure on the nerves of a part, it may give rise to very severe pain and spasm at a distance from its seat. The pains occasioned by the pressure of some forms of chronic abscess upon neighboring nerves, have been mistaken for those of rheumatism or neuralgia. When blood-vessels come into relation with an abscess, they usually become coated by a thick layer of lymph, which protects them from injury. In some cases, however, they are obliterated by the conjoined effects of the pressure and the inflammation, in which they as well as the adjacent tissues partake. In other cases, more particularly in strumous and cachectic individuals, the blood-vessels, not having been guarded by lymph, have ulcerated and burst into the cyst of the abscess, occasioning sudden and dangerous or even fatal hæmorrhage (p. 177). It is seldom, however, that a large artery or vein pours its contents into an abscess that has not been opened. These occurrences have chiefly taken place in the neck, in which situation both the carotid artery, as in a case described by Liston, and the internal jugular vein, have opened into the cyst of an abscess. The various mucous canals, especially the trachea and the urethra, may be injuriously compressed by neighboring abscesses; so also bones may become necrosed, and joints inflamed and destroyed, from the same cause.

Diagnosis.—The diagnosis of abscess, though usually easily made, at times requires close attention. The Surgeon believes that an acute abscess is about to form when, after rigors and some modification of the inflammatory fever, he finds the local signs characteristic of the formation of pus; more especially a throbbing pain in the part, with softening of any induration that may have existed, and œdema of the areolar tissue covering it. His suspicion is turned into certainty, and he knows that an abscess has formed, when, after the occurrence of these symptoms, fluctuation can be felt, and the other signs manifest themselves. The fluctuation may, however, readily be confounded with the undulatory sensation communicated by some tissues from the mere infiltration of sero-plastic fluid into them, or even without this, from their natural laxity, as is sometimes the case in the areolar tissue of the nates and thigh in persons of lymphatic temperament. This, indeed, is a difference of degree rather than of kind; as pus would make its appearance in the course of a few hours, if the tumor were left to itself. The mere occurrence of fluctuation, however, is not of itself sufficient to determine

more than that a fluid exists in the part. The question necessarily arises, is this fluid pus? In the majority of instances, the history of the case, the character of the pain, the previous existence and the continuance of symptoms of inflammation, enable the Surgeon to answer in the affirmative. But if, as in chronic or cold abscesses, there be only obscure evidence of inflammation having existed, and if the swelling be of long standing, the fluctuation being perhaps deeply seated and indistinct, the safer plan will be for the Surgeon to introduce an exploring needle, and to see what the true nature of the fluid is; by this simple means many embarrassing mistakes in diagnosis may be avoided.

The tumors with which abscesses may more easily be confounded, are those *soft solid growths* in which there is a high degree of elasticity, giving rise to a species of undulation, as in some kinds of encephaloid tumor. *Flu d tumors* of various kinds, such as cysts and enlarged bursæ, also may be confounded with abscesses. In these cases the previous symptoms, the situation, and the general appearance and feel of the tumor, will usually enable the Surgeon to effect a ready diagnosis; but should any doubt exist, the exploring needle or trochar must be introduced, when, if pus be present, a drop or two will escape. The "suction-trochar" (Fig. 75), or the "aspirator," is of especial service

Fig. 75.—Suction-Trochar.

in cases in which it is desirable to withdraw some of the contained fluid, for closer examination. The diagnosis of an abscess having pulsation communicated to it by a subjacent artery, from an *aneurism*, will be discussed when we come to speak of that disease.

Prognosis.—Abscesses vary greatly in danger, according to their nature, size, situation, and cause, and the constitution of the patient. The chronic form is usually attended by more risk than the acute and the diffuse. The puerperal and pyæmic are especially hazardous to life, being generally associated with a bad state of the blood. The large size of some abscesses is an element of great risk, occasioning not only a very abundant discharge of pus, but likewise great constitutional irritation when they are opened. Abscesses that are situated in the neighborhood of important organs, as about the neck of the bladder, or in the anterior mediastinum, are necessarily much more hazardous from the peculiarity of their situation than those which are met with in less important regions. The cause of the abscess also influences the result; if it be a piece of dead bone that can be removed, the discharge will speedily cease if the fragment be taken away, but if it be so situated that it cannot be got rid of, it will, by acting as a continuous source of irritation, keep up a discharge that may eventually prove fatal. The constitution of the patient influences our prognosis. Such an amount of discharge as would inevitably prove fatal in a cachectic system, may influence a sound one but very little; so also, the wasting effect of an abscess is better borne about middle age than at either of the extreme periods of life.

Treatment.—The treatment of suppuration presents three points requiring attention. The first object should be to prevent the formation of matter; the next to take steps for its evacuation when formed; and the last to endeavor to close the cavity that results.

In order to *prevent the formation of matter*, it is necessary to get rid of any local irritant that may exist, thus dead bone should be removed, or extravasated urine let out of the areolar tissue. After this has been done, the preventive treatment must consist in the active employment of local antiphlogistic means, such as ice and cold evaporating lotions, any slight tenderness that continues after the inflammation has subsided must be removed; and the swelling from exudation-matter, which is especially the precursor of chronic abscess, must be got rid of by the continuous application of some discutient lotion. One composed of iodide of potassium ʒi., spirits of wine ℥i., water ℥vij., is extremely useful; in some cases absorption may advantageously be promoted by mercurial ointments or plasters. When once pus has formed, it is a question whether it can be absorbed again; in general, it certainly cannot, more especially if once a distinct cyst have formed around it, but in some cases it may undergo absorption; thus, in hypopyon, we occasionally observe that the pus deposited in the anterior chamber of the eye is removed; and I think it probable that the same may happen when pus is infiltrated into the tissues of a part, without a very distinct wall surrounding it. The more fluid parts of chronic abscesses occasionally become absorbed, leaving a cheesy residue, which may degenerate into cretaceous matter.

When, notwithstanding the employment of appropriate means, it is evident that pus is about to form, the treatment should be completely changed, and, by the aid of warmth and poultices, an endeavor should be made to *hasten suppuration*. When this is fully established, the abscess having become "ripe," steps must be taken for the *evacuation of the matter*. The treatment of acute and of chronic abscesses differs in some respects. In discussing the **Treatment of Abscess**, we shall consider, in the first instance, its management by the methods ordinarily in use, and secondly, by the antiseptic plan.

In the **Acute Abscess**, the matter should be let out as soon as it is fully formed, especially in those varieties of the disease connected with a morbid state of the system, as in the metastatic and pyæmic forms. When this is done, the constitution at once experiences great relief, the fever and general irritation subsiding materially; the free incision not only letting out the pus and lymph, but removing tension, and, by encouraging local bleeding, lessening the inflammatory action. The rule of opening an acute abscess early is especially imperative when the pus is formed in the sheaths of the tendons and under fibrous expansions where there is much tension; also when it is situated deeply in the areolar planes of a limb, under the larger muscles, where it has a tendency to diffuse itself extensively. In those cases, likewise, in which pus is lodged in close proximity to a joint or under the periosteum, it must be let out early; so also, when it presses upon mucous canals or important organs, as on the urethra or trochea, or when it is dependent on the infiltration of an irritant fluid into a part, as in urinary extravasation, it must be evacuated without delay. The pus should always be let out early, before the skin covering it is thinned, when the abscess is situated in the neck or in any other part where it is desirable that there should be as little scarring as possible.

In **Chronic Abscess,** the rule of surgery is not so explicit. Here the collection is often large, coming on without any very evident symptoms and giving rise to no material inconvenience; but, if it be opened putrefaction of the pus, consequent upon the entry of air into the extensive cyst, will give rise to the most serious constitutional disturbance, setting up irritative fever, or giving rise to pyæmia; and, should the patient escape this danger, the drain of an abundant suppuration may speedily waste him. Hence, it not uncommonly happens that a patient may carry a chronic abscess unopened, without any very serious disturbance, for many months or even years; but when it is once opened, he dies in a few days. If, however, the chronic abscess be so small that no danger is to be apprehended from the inflammation of its cyst, or if it be situated in parts where it may give rise to dangerous pressure, the matter should be let out without delay.

There are three modes by which abscesses may be opened, each of which possesses advantages in particular cases;—these are *Incision*, *Tapping* with a trochar, and making an aperture into the cyst with *Caustic*.

Incision is the only plan that should be practised in *acute abscesses*. For this purpose a lancet, an abscess-bistoury (Fig. 76), or a sickle-

Fig. 76.—Abscess-Bistoury.

shaped knife, may be used. The incision should be made either at the point where fluctuation is most distinct, or at the most dependent part of the tumor, so as to prevent after-bagging of the matter. It should be made by holding the bistoury or lancet short, and introducing it perpendicularly into the softened part. If the depth to be reached be considerable, a bistoury should be used, the blade of which should be half turned round after its introduction, when the pus wells up by its side, the point being felt to move freely in the cavity of the abscess. The incision must then be continued for a moderate extent in the direction of the natural folds of the skin of the part, or in the course of the vessels. The pus should be let out freely, so as to allow the walls of the abscess to collapse, but it should not be forced out by squeezing the sac.

It may happen, after the escape of the pus, that the cavity of the abscess is filled with blood by the rupture of some small vessel situated in its walls; this, however, is of little moment, the hæmorrhage speedily ceasing on the application of pressure, of a bandage, or of cold.

Provided the incision have only to be carried through the integumental structures and fascia, in order to afford an outlet for the pus, there can be but little danger of hæmorrhage from the accidental wound of any blood-vessel of importance; and, should bleeding occur, it will probably be of a venous character, and may be arrested by pressure and position. But when the abscess is more deeply seated than this, lying under the superficial muscles, which it will then be necessary to penetrate, more serious consequences may ensue, and the incautious use of the knife may lead to the most perilous results. This is more particularly apt to occur in deeply seated periosteal abscesses of the thigh; and I have more than once known such profuse arterial hæmorrhage follow incisions made for the purpose of evacuating pus deeply lodged in the limb in these cases, as to necessitate the ligature of the femoral artery.

In order to avoid this danger, Hilton has advised that abscesses so situated should be opened in the following way. An incision is made through the integuments and fascia so as to expose the muscle under which the pus lies; a director is then pushed through the substance of the muscle into the cavity of the abscess, and along the groove of this as a guide a slender pair of dressing-forceps is pushed; when it reaches the abscess the blades are opened up, the muscular fibres separated, and free exit given to the pus.

After the opening has been made, a poultice or water-dressing must be applied. The cavity left eventually fills up either by the coalescence of its sides, or by granulating from below; if it fill again with pus, a fresh incision, termed a "counter-opening," must be made in the most dependent part. Nothing is more dangerous than pent-up matter in imperfectly opened abscesses. It speedily decomposes and becomes offensive, gives rise to local irritation and inflammation, and predisposes to the occurrence of erysipelas and pyæmia. In order to prevent these evil consequences, recourse must be had to free openings in dependent situations, and the use of the drainage-tube.

In the treatment of *chronic and cold abscess*, any one of these three plans may be employed for opening the sac. If it be small, an incision should be made into it at once. If the collection be considerable, we must wait until an opening has been rendered necessary by the tendency to implication of the skin, or by injurious pressure being exercised on important parts; the pus should then be let out by the valvular aperture recommended by Abernethy, the object being to limit the entry of air into the interior of the abscess, so as to lessen the chance of putrefaction of any pus that is left, and of consecutive inflammation of the cyst. The valvular opening is made by drawing the skin covering the abscess well to one side, then passing the bistoury directly into the sac, and allowing as much of the pus to escape as will flow out by the collapse of the walls of the abscess; before the matter has quite ceased to flow, and consequently before any air can have entered the sac, the skin should be allowed to recover its natural position, so that the aperture in it and in the cyst may no longer directly communicate. A piece of plaster, or of lint soaked in collodion, should be placed upon the external wound, which will probably heal under this covering in the course of a short time. When the cyst of the abscess has again filled somewhat, this process may be repeated; so that, less and less pus being allowed to accumulate in it before each succeeding evacuation, it may gradually contract and close.

Instead of making the valvular opening in this way, a chronic abscess may sometimes be advantageously opened by **Tapping with a Trochar and Cannula** of moderate size, the instrument being introduced obliquely between the skin and the abscess, and then made to dip down into the sac. After the withdrawal of the cannula, the aperture may be closed as in the former case. There is, however, one disadvantage in this plan of opening abscesses; that, if the discharge be curdy or shreddy, it is very apt to block up the cannula or tube, and thus to interfere with the proper evacuation of the matter. The abscess may be emptied by the **Aspirator**, the entrance of air being thus effectually prevented.

Potassa Fusa, though its application be painful, may be advantageously used for opening those chronic abscesses, the skin covering which is much undermined, congested, and discolored. In these cases I commonly employ it with great advantage. It is also useful in the after-treatment, when much solid plastic matter is left, dissolving this

away by exciting inflammation around it, and thus preventing the formation of sinuses which are otherwise apt to occur.

In some forms of abscess it will be found that those processes which are necessary for the contraction and closure of the cyst, after its contents have been evacuated, do not readily take place; and it becomes necessary to have recourse to other measures, in order to excite sufficient healthy inflammatory action to bring about the closure of the cyst of the abscess. With this view, a **Seton** of two or three threads may very usefully be passed across the cyst by means of a nævus-needle, or by a long straight needle pushed up through the cannula used for tapping (Fig. 77). It should be left in for a few days, by which time healthy

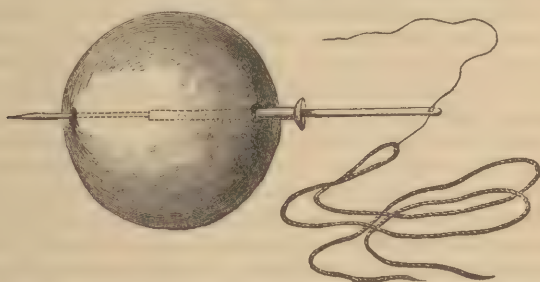


Fig. 77.—Introduction of Seton into Abscess through Cannula.

inflammation will be set up. In other cases again, after the cyst has been tapped, the red wash or some tincture of iodine should be **injected** and left in. These methods of exciting inflammation are especially useful when the cyst-wall is thin, and of a very chronic character. When the walls are very thick and dense, as sometimes happens in abscesses of very old standing situated in the neck, an elliptical piece of the anterior portion of the cyst should be dissected out and the cavity lightly dressed with lint, and allowed to fill by granulation. This plan of treatment is often very successful; and I have by it cured abscesses in the neck of seven or eight years' standing, which have resisted every other plan employed.

The **Drainage-tube** was introduced into surgical practice by Chassaignac. It is of the greatest value in keeping the abscesses, and, indeed, the interior of wounds generally, free from those fluid accumulations which, being in contact with the air, are apt to undergo decomposition, and thus become the source alike of local irritation and of constitutional infection.

The drainage-tube is especially useful in the treatment of chronic abscesses. This instrument is used in the following way. The abscess having been punctured, a small India-rubber tube, one-sixth of an inch in diameter, having several sides holes punched in it, is passed into the cavity, one end being allowed to hang out for the pus to drain away. These tubes may very conveniently be introduced by being fixed on to the end of a forked probe (Figs. 78, 79), by which the tube is carried into the abscess and

Fig. 78. Forked Probe for introducing Drainage-tube.

Fig. 79. Drainage-tube and Forked Probe.

left there on the withdrawal of the probe. Another plan consists in passing the perforated India-rubber tube completely across the abscess, drawing it out through a counter-opening, and tying the two ends together. By this contrivance the pus is carried off by the side of rather than through the tube as quickly as it is secreted, the walls of the abscess collapse, and, as gradual closure takes place, the tube may be withdrawn. In some cases the drainage-tubes have appeared to me to act in another way than by merely removing the purulent secretion; viz., by irritating the wall of the abscess just as a seton would, and thus setting up increased activity, and materially augmenting the discharge. On their withdrawal, however, this stimulation has been found to be beneficial, causing a speedier closure of the suppurating cyst.

The antiseptic treatment has been successfully applied of late years by Lister, of Edinburgh, to the treatment of both acute and chronic abscesses. By its means all the advantages of a free opening, giving ready exit to the discharges, can be obtained without the dangerous consequences which often follow the modes of treatment which have just been described. The practice is founded upon the following principles:—1. The formation of pus, whether on the surface of a granulating sore or in the cavity of an abscess, is due to the presence of some abnormal irritation of the tissues.—2. In the vast majority of cases, the primary cause of the formation of an abscess is of a temporary character, its exact nature often being uncertain; in other cases a distinct cause may be readily found, as an injury in an unhealthy subject, or the presence of an irritating foreign body.—3. The primary cause of the formation of an abscess being removed or having disappeared, the irritation caused by the tension of the parts in consequence of the accumulation of fluid is sufficient to cause the continuance of the process of suppuration, and the pointing of the abscess.—4. If the cause of irritation be removed and no other supplied in its place, and if no other cause that will still be present have co-existed with it, all suppuration will cease on the relief of tension by opening the abscess, the only discharge being of a serous nature, coming from the surface of the granulations lining the cavity of the abscess. If this discharge be pent up in the cavity, tension will be again produced, and acting as an irritant, will cause fresh suppuration; but if the discharge be allowed to drain away it will rapidly diminish, and the sac of the abscess will be obliterated by the ordinary processes of contraction and cicatrisation. If dead bone exist at the bottom of the cavity of the abscess, the reparative process, involving absorption of the dead bone, will be very slow, the serous discharge often continuing for months without change, unless allowed to decompose, when it will rapidly become purulent and enormously increased in quantity.—5. In the ordinary method of opening an abscess, although the irritation due to tension is removed, a fresh irritant is admitted in the shape of the decomposition of the discharges, which in the mildest cases will seriously delay the closing of the cavity of the abscess, while in many, such as large psoas or lumbar abscesses, it may lead to such an amount of constitutional disturbance as to be rapidly fatal.—6. The cause of decomposition is not the admission of the gases of the air, but the presence of organic germs which are constantly floating in the atmosphere, and whose activity is readily destroyed by the presence in the air of a moderately strong vapor of carbolic acid, sulphurous acid, or some other volatile antiseptic. Lister, therefore, in his method of treatment aims at the following objects:—1st. The free opening of the abscess, so as completely to evacuate its contents, and to allow the free drain of

discharges afterwards—that is to say, the complete removal of tension and the prevention of its return; 2d, the entire exclusion from the opening into the abscess of ordinary air unmixed with a strong vapor of carbolic acid or other volatile antiseptic body; and 3d, the absorption by some porous material impregnated with a powerful antiseptic, of all discharges as soon as they escape from the wound—in short, the prevention of decomposition in the sac of the abscess, or in the discharges lying about the wound.

The antiseptic which Lister has found the most convenient for these purposes is carbolic acid. The treatment requires great care in management, and must be considered with minute attention to all its details. The materials required are a *solution of carbolic acid in water* (1 to 40), and a *solution of olive oil* (1 to 10), *antiseptic gauze*, composed of a coarse gauze impregnated with a solution of carbolic acid in paraffin and resin, and a *protective* consisting of oiled silk coated with copal varnish, and covered with a thin layer of a mixture of dextrine and starch. The object of these various materials is as follows. The *watery solution* is used when the action required is not of long duration, but when a vapor of carbolic acid is intended to be kept up round an open wound, the watery solution very readily parting with its carbolic acid. It may be used in two ways, either as a spray blown upon the part from an ether-spray apparatus, or by means of a piece of linen rag soaked in the lotion and laid over the open wound while the more permanent dressings are being prepared. The *oily solution* retains its carbolic acid much more firmly, and may be used where the action is required to be more prolonged, as in the fresh opening of an abscess where the rush of pus might wash the watery solution out of the piece of rag placed over the wound. It is also used for greasing the parts round the abscess, especially if very hairy or dirty, and for greasing any instrument to be used during the operation, or the Surgeon's finger if he intend to introduce it into the cavity of the abscess. The *antiseptic gauze* retains the carbolic acid much more firmly than the oily solution, continuing to give off a vapor of the acid for many months even when exposed freely to the air. It is intended to be placed over the wound to absorb any discharge from it, and to keep it free from decomposition. Its action is exactly the same as that of carded oakum, but it is more cleanly, more easily applied, and more certain in its action. The *protective* is a substance impermeable to carbolic acid, intended to be placed over a granulating wound in order to prevent, as far as possible, the direct contact of the carbolic acid, which, acting as a powerful irritant, would arrest or at least delay healing, and cause profuse suppuration. It is used over granulating sores left after opening abscesses, &c., when it is thought desirable that they should heal. It is soaked in carbolic acid and water (1 to 40) before it is applied, so as to destroy any germs that may be resting upon it; and after application, the small proportion of carbolic acid on its surface being rapidly absorbed by the sore beneath, it is left almost perfectly free from any irritating qualities.

The *opening of an abscess according to the antiseptic method* is, therefore, done as follows. The skin all round for at least nine inches being well washed with the watery solution, a spray of the same solution is blown upon the part where the incision is to be made, and the abscess is opened with a knife which has been dipped in the watery solution. The pus in the abscess being squeezed out, a plug of lint soaked in the oily solution, or a piece of the gauze soaked in either the watery or the oily solution, is pushed into the opening so as to act as a drain, and

allow the escape of the serous discharge, for the first few days; or an India-rubber drainage-tube, soaked in carbolic acid, may be used as before described in the ordinary treatment of abscesses. The part is then wrapped in the gauze, folded eight layers thick and extending six or eight inches or more, according to the amount of discharge, on each side of the opening; the spray must be kept up until the whole part is enveloped in the gauze. Over this dressing must be put a piece of gutta-percha tissue, or of thin macintosh cloth dipped in carbolic acid and water, so that the discharge may not soak through at one spot and decompose, but may be evenly diffused over the whole of the dressing. Over this water-proof material a bandage composed of the antiseptic gauze may be placed, and over all a common bandage if it be thought necessary. If the spray-apparatus be not at hand, or if there be no assistant to work it, the same objects may be obtained by the judicious use of a piece of rag soaked in the oily solution. It must be held over the part where the opening is being made, and dropped on immediately it is completed, and the pus squeezed out from underneath it. The dressing can then be put on over it, a corner of it being left exposed by which it can be drawn out as soon as the gauze is firmly over the opening. During the after-dressings it is hardly necessary to use a rag soaked in the oily solution, unless the discharge be very profuse; for, as the time occupied is very short, a piece of linen soaked in the watery solution will answer all the purposes required. It must be put over the whole part where the incision is, and the dressing removed from under it without exposing the wound to the air at all. If it be desirable to look at the opening, the rag may be raised while a small stream of carbolic acid and water is run over the wound by means of a syringe, an Esmarch's irrigator, or a sponge. The dressings should be repeated on the day after the opening of the abscess, and, after that, every alternate day, or every third or fourth day, according to the amount of discharge.

It is not to be imagined that in all cases this mode of treatment will entirely prevent the formation of pus after the opening of an abscess, as, although tension may be removed and decomposition may be prevented, other causes of irritation may be present; but, in all cases, the constitutional disturbance will be greatly diminished by the prevention of the irritation necessarily resulting from the presence of fetid discharges in the cavity of the abscess and about the wound. If the discharge do not escape freely a common India-rubber drainage-tube may be inserted, after being soaked for 24 hours in a concentrated watery solution of carbolic acid. If, as occurs in rare cases, decomposition has occurred in the abscess before it is opened, it may be corrected by injecting the sac of the abscess with some antiseptic agent, and for this purpose forty grains of chloride of zinc to one ounce of water will usually be found the most effectual.

Of the great value of this method of treatment, more especially in the case of chronic and cold abscess, there can be no doubt in the mind of any one who has given it a fair trial. By the "Antiseptic Method," properly carried out, and in accordance with a scrupulous attention to those details that are necessary for its successful employment, it will be found that the formation of pus speedily diminishes, that the danger of its decomposition is removed, and that the chance of constitutional irritation is consequently greatly lessened if it be not entirely removed—that those dangers, in fact, which are apt to result from the opening up of large suppurating cavities are greatly obviated by the use of antiseptic dressings.

Constitutional Treatment.—With the view of preventing the occurrence of suppuration, we must be careful to maintain the powers of the system, and not to reduce the patient too much even if the inflammation be of a sthenic character at the outset. Suppuration is a condition of debility, and is especially predisposed to by any previously existing enfeebled state of the system, or by malnutrition. Another reason for the avoidance of the early employment of debilitating means is that, if suppuration once be established, the drain on the system may eventually be so considerable as to require all the patient's powers to enable him to bear up against it. Hence they should be husbanded from the first. After the discharge has taken place, nourishing, tonic, and even stimulating treatment will be required in proportion to the amount of debility that is induced. Amongst the most useful medicinal agents are mineral and vegetable tonics, the mineral acids, and cod-liver oil in the more chronic stages. Attention to hygienic conditions, with change of air, and residence at the sea-side, are also valuable. When hectic comes on, the same general tonic plan must be adopted, while we have recourse to means adapted to meet the local symptoms. Thus, acids are required to check the sweating, astringents to arrest the diarrhœa, and as much mild nourishment as the patient will bear to support the strength.

HÆMORRHAGE INTO THE CAVITY OF AN ABSCESS is not of unfrequent occurrence. It may arise from three sources: 1. Oozing of blood from the vascular wall of the abscess; 2. An ulcerated vein; 3. Ulceration or sloughing of the coats of a neighboring artery.

The **bleeding** which occurs **from the abscess wall** is the most frequent, and the least important. It sometimes takes place before the abscess is opened, the pus that escapes being then found to be sanious and mixed with small coagula. More commonly it occurs after the opening of the abscess, in consequence probably of the wall having lost support of the contained pus, when the delicate vessels in the soft plastic and very vascular lining give way, and the cavity speedily fills with blood. In these cases the hæmorrhage may always be arrested by laying the cavity of the abscess freely open, turning out the coagula, stuffing it with strips of lint, and applying pressure with a bandage. It usually, however, ceases of itself as soon as the cavity has been freely opened up and the interior exposed to cold air.

Hæmorrhage from **Ulceration** *extending into a neighboring Vein*, is necessarily far more serious. It has usually happened from sloughy abscesses formed on the side of the neck or under the angle of the jaw, as a consequence of scarlatina in strumous and unhealthy individuals, opening up the internal jugular vein. But it may arise, independently of any specific inflammation, in cachectic patients. In these distressing cases, the only treatment that can be adopted is, to plug the cavity of the abscess with lint soaked in a solution of the perchloride of iron, and supported by bandage or plasters. In this way the fatal event may be for a time perhaps delayed; but it is inevitable ultimately, the blood bursting forth by the sides of the plugs as these become loosened, or as the sloughing action opens up the vein more widely. The effect of the bleeding is greatly aggravated by the depressed state of the system, laboring under the conjoined influences of a large infiltrated and sloughy wound and a specific poison.

If the hæmorrhage arise from the *Ulceration of a large Artery*, the case necessarily becomes one of extreme urgency. I have known this condition to occur in the neck and in the thigh; in the neck from sloughy scarlatinal abscess implicating the carotid; in the thigh, from the ex-

tension of ulcerative action from abscess and sinuses to the deep femoral. When this untoward complication of abscess occurs in the neck, the hæmorrhage is usually so sudden and so profuse that the Surgeon has not time to tie the carotid before life is extinguished. In the thigh the case is not so urgent. Warnings by repeated small hæmorrhages may have enabled the Surgeon to adopt means to restrain the bleeding; and, in the case to which I allude, that of a young man, the femoral artery was tied successfully. In these cases, it is worse than useless to trust to secondary means for the arrest of the bleeding. When practicable, the artery should be compressed, the cavity freely opened up, and the bleeding vessel sought for and tied. If it cannot be found, the main trunk must be ligatured; and for obvious reasons this is the only course that can be pursued in the neck.

Sinus and Fistula.—After an abscess has been opened, its cavity may not fill up completely, but, contracting into a narrow suppurating track, may form a canal without disposition to close, and from which a small quantity of pus constantly exudes, thus constituting a **Sinus** or **Fistula**.

The *Causes* of this non-closure of the cyst of an abscess may be referred to the following heads:—1. The presence of a foreign body, as a piece of dead bone at the bottom; 2. The passage of irritating secretions, as urine, fæces, saliva, &c., through the abscess; and 3. The contraction of neighboring muscles; as when the abscess is in the neighborhood of the sphincter ani, and as occasionally happens in abscesses about the limbs.

The difference between a sinus and a fistula is this—that in the sinus there is only one external opening, in the fistula two or more. The track of a sinus is closed at one end, that of a fistula open at both.

The orifice of a sinus or a fistula when situated in hard and condensed tissues is often very small, depressed, and perhaps covered by a scab. In soft tissues it is commonly large and widely open; when communicating with bones there are usually soft florid granulations obstructing it.

Structure.—A sinus or fistula consists of a narrow channel, often long and winding, having an external orifice usually somewhat protuberant, and situated under or among loose florid granulations. The walls of this channel, which are always indurated, are lined by a low form of connective tissue resembling mucous membrane; this, however, it is not, but simply consists of a layer of imperfectly formed granulations, exuding ichorous pus. If the orifice be occluded, this pus will collect within the sinus, and, distending its walls, reconvert it into an abscess. In structure, therefore, a sinus or fistula may be said to be a long, narrow, chronic abscess, with a permanent external aperture.

The **Treatment** of a sinus or fistula has reference to its cause in the first instance; for, until the foreign body that keeps it open and maintains the discharge has been removed, it will be useless to attempt its closure. After the removal of the obstacle to healing, we may endeavor to procure obliteration of the sinus by one of three methods.

1. *Pressure*, by means of a roller and graduated compress, so as to cause an agglutination of its opposite sides, is useful in those cases in which the sinus is recent, without much surrounding induration, and so situated, as upon the trunk, that pressure can easily be applied.

2. A more healthy inflammation may often usefully be excited in the sinus, by *injecting* it from time to time with "red wash" or with tincture of iodine, by passing the threads of a *seton* or a drainage-tube through it, or by stimulating it by the occasional contact of a *red-hot iron*. This

galvanic cautery may often be employed with much success in the treatment of fistulæ and sinuses, to which other methods are not very applicable.

3. The last method consists in *laying open the sinus* from end to end, and then dressing the wound so that it may heal from the bottom; in this way neighboring muscles, that have kept it open by their contractions, may also be set at rest. The division of the sinus should be made with a probe-pointed bistoury, introduced through the external opening either by the aid of a director or without such assistance. The operation should be done effectually, the sinus being usually followed as far as is prudent, and laid completely open.

4. A fistula may be successfully and almost painlessly opened up by the slow action of the *elastic ligature*. A thin cord of vulcanized India-rubber being drawn through and tied tightly, ulcerates in a few days through the soft part covering the track of the fistula. This plan is useful in cases in which hæmorrhage is apprehended or the patient dreads the knife.

CHAPTER VI.

ULCERATION.

Ulceration is that process by which a solution of continuity with loss of substance, attended with the secretion of ichorus pus, is produced by molecular death of the superficial tissues. It may be the result either of some influence acting in the part itself, or of the destruction of the part by the sudden application of chemical agents. Two distinct stages attended by the most opposite phenomena are described as constituting the process of ulceration; viz., 1, the period of *Destruction*; 2, the period of *Repair*. To the first only can the term ulceration be properly applied, the stage of repair being one of deposition. The term ulceration is applied to the destruction of superficial tissues; although the process may be regarded as having a close analogy with the destruction of tissue which attends suppuration within the texture or substance of parts. It is most common on the cutaneous and mucous surfaces, but occurs likewise on the lining membrane of blood-vessels and on serous membranes.

Ulceration is so intimately allied with sloughing and gangrene, that it is very difficult to separate its causes from those of these other conditions.

Causes.—The **Predisposing Causes** of ulceration are chiefly found in those conditions that interfere in any way with the nutrition of a part. A feeble circulation, such as often exists in the lower limbs, in the alæ of the nose, and in newly formed or recently cicatrized tissues, predisposes to the formation of ulcers. As age advances, nutrition becomes impaired and the circulation less active, and slight causes suffice to disintegrate the structure of a part; and malnutrition, or loss of innervation from any cause, by lessening the vitality and the resisting power of tissues, increases the tendency to ulceration. Hence we commonly see ulcers of the legs in elderly people, more particularly amongst the poorer classes, arising from slight irritation or pressure. In the dogs that Magendie starved by feeding them on sugar, gum, or

oil and distilled water, ulceration of the cornea occurred. This must have been the result of simple malnutrition, rather than of inflammation.

Tissues that have been congested for a long time are apt to inflame under the influence of some trifling exciting cause, and to run rapidly into ulceration. This usually commences in the centre of the part, where the nutrient action is lowest; here a small sore forms, which exudes thin unhealthy pus, and rapidly extends. So long as the sore is inflamed, it continues to spread, and reparation cannot take place. It would appear as if even a moderate degree of inflammation were too intense for the vitality of chronically congested tissues, or of those in which lowly organized fibrine has been effused. The more the vitality of a tissue is reduced, the less appears to be the degree of inflammation that is required to produce its disintegration and ulceration. Indeed, if the vitality of a part be sufficiently lowered, it may fall into a state of ulceration without the occurrence of inflammation, or with so slight a degree as to be scarcely appreciable; the ulcerative action appearing to arise from disintegration dependent upon the want of nutrition. Thus, for instance, in scrofula and other diseases in which there is an imperfect nutritive force, as in scurvy or syphilis, a tendency to softening and breaking down of structure, and consequent ulceration, exists; and this tendency is much increased by the occurrence of congestive or subacute inflammation.

Exciting Causes.—Ulceration may be directly excited in several distinct ways on the cutaneous and mucous surfaces.

1. There may be such a degree of *acute local inflammation* as rapidly to produce molecular death of the part. If the action be not very acute, and the destruction of the tissues not very rapid or extensive, the disorganized matters become mixed with pus, and are discharged in the form of a dirty, brownish, puriform fluid. If the action be more violent, than this, complete disintegration may not take place in the affected part, but shreds of the spoilt tissues continue attached for some time to the ulcerated surface, and give it a very ragged appearance. If the inflammation be more intense, layers of disorganized tissue, constituting "sloughs," are formed, and remain in contact with the ulcerated surface, often covering it completely, and extending with considerable rapidity into the neighboring healthy structures. In this manner some of the forms of phagedænic or sloughing ulcer are formed.

2. *Chronic inflammation* is perhaps the most common cause of ulceration. The process of formation of an ulcer under this condition has been well described by Billroth. "Let us suppose," he says, "that we have a chronic inflammation of the skin of the leg, say on the anterior surface of its lower third. The skin is traversed by dilated vessels, hence it is redder than normal; it is swollen, partly from serous, partly from plastic infiltration; and it is sensitive to pressure. Wandering cells are infiltrated, especially in the superficial parts of the cutis; this renders the papillæ longer and more succulent; the development of the cells of the rete Malpighii also becomes more plentiful, and its superficial layers do not pass into the normal horny state; the connective tissue of the papillary layer is softer, and becomes partly gelatinous. Now, slight friction at any point suffices to remove the soft, thin, horny layer of the epidermis. This exposes the cell layer of the rete Malpighii; new irritation is set up, and the result is a suppurating surface, whose upper layer consists of wandering cells, the lower of greatly degenerated and enlarged cutaneous papillæ. If at this stage the part were kept at perfect rest, and protected from further irritation, the epidermis would

be gradually regenerated, and the still superficial ulcer would cicatrise. But usually the slight superficial wound is too little noticed, it is exposed to new irritations of various kinds; there are suppuration and molecular destruction of the exposed inflamed tissue, then of the papillæ, and the result is a loss of substance which gradually grows deeper and wider; the ulcer is fully formed."

3. Ulceration sometimes commences in the crypts or follicles which open on the mucous surface, some modification of structure taking place in their epithelial linings, which leads to the formation of circular depressed ulcers.

4. A vesicle or pustule forming on the cutaneous surface, and shedding its contents, very commonly gives rise to an ulcer, as in rupia and pemphigus.

5. Suppurative inflammation not unfrequently occurs in the subcutaneous or submucous areolar tissues, and, by undermining and consequently destroying the vascularity of the skin and mucous membrane, and thus arresting its nutrition, gives rise to ulcer.

6. Ulceration may be produced by a severe mechanical injury, by long continued pressure, or by the action of an irritant, producing a direct breach of surface.

7. In some specific cases, ulceration is preceded by the formation of a morbid growth, tubercle, or tumor, in which inflammation and disintegration of tissue, and consequent lesion of substance, occur.

Situation.—Ulcers may be situated upon any part of the cutaneous surface as the result of violence; most commonly, when arising from some specific affection, they occur in particular situations, as on the penis, lips, tongue, &c.; but when they occur from disease of non-specific character they are usually seated on the leg. The lower half of the leg is the common seat of these simple ulcers, which occur there in every possible variety. They are most common at or after the middle period of life, and are more frequently met with in the poorer classes. They are especially predisposed to by all those circumstances that favor weakness of circulation, and consequently low vitality of the part—as exposure to cold and wet, want of food, &c. The skin of the lower part of the leg is prone to these ulcerations, in consequence of its natural thinness, the feebleness of its circulation, more especially in advanced life, and its liability to venous congestions from position. Ulcers that once form here are slow in healing and very liable to recur, because the conditions that led to their formation may still exist, and there is often an absence of a proper subcutaneous areolo-adipose bed, with the consequent tendency to adhesion of the under surface of the ulcer to the aponeurosis or periosteum.

Stages.—In whatever way ulceration commences, it presents three distinct stages: viz., 1, *Extension or Slough;* 2, *Arrest* with *Deposit of Plastic Matter;* and 3, *Repair by Granulation* and *Cicatrisation.*

1. When the ulcer is **Spreading**, there is always a circle of inflammation around it, as evinced by redness, heat, and a burning, throbbing pain; its edges are jagged, eroded, or sharp cut and undermined; its surface, which is more or less circular or oval, spreads nearly equally from one starting-point, and is covered with a greyish or yellowish, soft, adherent slough. In ordinary cases this is thin and shreddy, but in some forms of ulceration it is soft, pultaceous, and elevated above the surrounding parts. There is either no discharge at all, or only a bloody, ill-conditioned fluid, hardly deserving the name of pus, that drains from the surface.

2. In the next stage, that of **Arrest**, the symptoms of inflammation diminish, and a layer of plastic matter is deposited in the tissues forming the base and sides of the ulcer. This not only serves to arrest or limit the further process of ulceration, but becomes the medium of ultimate repair. The surface begins to clean, the grey adherent slough separating in fragments and dissolving away in the discharge, which gradually loses its sanious tinge, and assumes more the characters of healthy pus, though still very scanty. The surface continues flattened, its sensibility diminished, and the edges are often elevated and indurated. In this stationary condition an ulcer may remain many months; and it is that in which we commonly find chronic sores.

3. The last stage, that of **Repair**, is characterised by the formation of granulations, which may be looked upon as the turning-point in ulceration. Until granulations are formed, ulceration is a wasting process, or at most stationary; as soon as they are formed, repair commences. Instead of a tendency to extension and erosion, and to concavity, we now find a disposition to contraction and deposition, and to convexity of the surface, which assumes a bright red hue, of a vermilion or scarlet tinge, and appears to be studded with minute papillæ: the edges become rounded and smooth down towards the surface, losing their sharp cut appearance; and the discharge assumes the characters of healthy pus.

REPAIR OF ULCERS.—We now proceed to study the changes that occur in an ulcer during the stage of repair—the processes of *Granulation* and of *Cicatrisation*.

Granulation.—So soon as inflammation and extension of ulceration are checked, the surface of the ulcer, as has already been stated, becomes covered by a layer of plastic matter. This plastic layer, separating the ulcer from surrounding and adjacent tissues, forms a basis from which the granulations, the organs of repair, spring up. Before this plastic basis can be deposited, it is necessary that the inflammation be reduced within those limits that are compatible with plastic effusion. So long as inflammatory action exceeds this limit around the edge or at the base of the ulcer, no lymph is effused. But as soon as this undue action is checked, lymph, which becomes vascularised by vessels shooting into it from below, is thrown out, and assumes a granular form from the formation of papillæ, or granulations, which are composed of exudative matter that has become vascularised. In the great majority of cases, granulations are formed only on surfaces exposed to the air and secreting pus; but they may be formed without exposure to the air or the formation of pus, as Hunter and Paget has shown to occur in some cases of fracture, the ends of the bones being covered by a distinct layer of florid granulations That these granulations are in reality composed of lymph that has become vascular, is evident from the interesting fact observed by Hunter, and which every Surgeon must have had repeated occasion to verify, both in wounds and in compound fractures, namely, that a portion of bluish-white semitransparent lymph effused on the surface of the sore or denuded bone is seen to become vascularised, and to be converted into two granulations, in from twenty-four to forty-eight hours.

The microscope shows that granulations are composed of cells heaped up without much, if any, apparent order, and connected by but little intermediate substance. When single, they are colorless; when in clusters, they become ruddy. It is interesting to observe how these cells undergo different changes in different parts of the same ulcer. Those situated at the base nearest the attached surface of the granulation, constituting its deeper layers, undergo development into filaments and

fibro-cellular tissue; those on the surface are either thrown off in a rudimentary form, or as pus-cells; while those at the edges become converted into epithelial scales. Thus we see the same process giving rise to granulation-cells, to pus-cells, to epidermis, and to fibro-cellular tissue.

The *development of vessels* in granulations—a most wonderful and beautiful process, by which thousands of vessels may form in a day on a healthy granulating surface—is identical with their general development in lymph, which will be described in Chapter VII.: a series of loops and arches being formed as outgrowths from neighboring vessels.

The *sensibility* of granulations varies considerably, being often greatest in those which spring from tissues that are naturally the least sensitive, as bone for instance. No nerves have been traced in granulations; hence their apparent sensibility would appear to depend upon that of the subjacent inflamed tissues.

The *characters* of granulations afford important indications to the Surgeon as to the condition of the surface from which they spring, and the state of the patient's general health. Granulations indicative of a healthy local and constitutional condition are small, florid, pointed, closely set, and bathed with healthy pus; the use of which appears to be to cover and protect the tender surface with a soft lubricant coating, into which the granulations may sprout without being dried by the air, or readily damaged in any other way.

In a weak state of the sore, or of the constitution, the secretion of pus diminishes, and it loses its healthy character; the granulations become large, pale, and flabby, appearing to be œdematous from infiltration of serum, and assuming a glassy or semitransparent look, with a purplish hue. Occasionally hæmorrhage takes place into them, and they become broken down and sloughy. If, whilst a sore is healthily granulating, morbid action be set up in it, or in the economy—as by the supervention of erysipelas or fever—the granulations degenerate at once, and become rapidly absorbed, the surface of the sore assuming a greyish, sloughy look, and the formation of pus being arrested.

The **Healing Process**, or **Cicatrisation**, is that by which the ulcer closes and becomes covered by an integumental investment. Two distinct processes, though carried on simultaneously, are necessary for the accomplishment of this. These are, that the granulations assume a healthy character, and cover themselves with new cuticle, and that the surface of the sore contracts.

The first change that takes place in an ulcer that is about to undergo the healing process, is that the granulations become florid, and are bathed with healthy pus; the edges and surface of the sore then assume the same level—the granulations rising, and the edges subsiding. So long as there is any inequality in this respect, the process of cicatrisation cannot go on. The granulations nearest the edges become smooth, cease to pour out pus, and are glazed over with a thin, whitish-blue pellicle—which is the first appearance of new cuticle—composed of granulation-cells developing into epidermis. As cicatrisation advances, the part of the sore immediately inside this bluish-white line will be seen to be occupied by a red zone, which, in the course of four-and-twenty hours, becomes, in its turn, new epidermis, and appears to be the link between granulation and true cuticle.

At the same time that these changes are going on, contraction of the sore takes place. This would appear to be entirely a mechanical process, and not a vital action; it is owing to the conversion of the exudation-cells of the granulations into the filaments of cicatricial tissue, which, being

more closely packed and becoming drier, occupy less space (Paget). This contraction commences as soon as the sore presents a tendency to cicatrise and continues for a considerable time after this is completed.

Cicatrisation advances with greatest rapidity around the edges of the sore, the centre taking the longest time to heal, in consequence of the activity of the process appearing to diminish the farther the new epidermis extends from the old tissues. Indeed, if the ulcer be large, there may not be sufficient force for the cicatrisation of its centre. A sore of a circular shape usually takes a longer time to heal than an oval or elongated one. The new cuticle is formed at the edge only, and never primarily in the centre of an ulcer, unless islands of old skin be left there undestroyed, to serve as centres of cicatrisation. It would appear to be necessary for the healing process, that granulations have some of the old textures to be modelled upon, from the plastic force of which there is an impulse given that causes their development into analogous structure. It is in this way that the islets of skin implanted on a granulating surface by "skin-grafting" act beneficially as new centres of cicatrisation.

The *changes* taking place in a cicatrix do not cease with its formation. Two processes continue for a very considerable length of time afterwards: viz., the gradual contraction and the development of the cicatricial tissue.

We have seen that granulations tend to contract during the healing of an ulcer, and that the diminution in surface thus produced facilitates greatly its cicatrisation. Hence a scar is never so large as the original sore. This contraction continues, however, and not does attain its maximum until long after the completion of cicatrisation, often occasioning great puckering or deformity. The degree of contraction depends partly on the seat of the scar, but principally on the nature of the agent that produced the ulcer; if the scar be seated on a part where the skin is very tense, the contraction will be slight; if the skin be naturally loose, it will be considerable. The contraction that takes place in scars which result from burns is greater than that in those which occur from any other cause, often producing serious deformity and great distress to the patient. These results do not supervene in their fullest extent until after a lapse of some weeks or months from the infliction of the injury. This contraction would appear in some cases to be due, not only to the consolidation of the texture of the scar, but to its great size.

Further changes are wrought by time in the texture of a cicatrix. In the first place, its tissue assimilates more and more to the normal structures of the part; and secondly, its deep attachments become more movable. When a scar is first formed, it is thin, reddish, or bluish and shining, being composed of imperfectly developed filamentous tissue, covered by a thin epidermic layer. As it becomes older, it assumes a dead-white color, and becomes depressed, and gradually, but slowly, though many years may be required for the change, it "wears out;" that is to say, its structure more closely resembles that of the texture of the part in which it is seated. It never, however, becomes developed into true skin, as neither sebaceous nor sudoriferous glands nor hair form in it.

Coincidently with these changes, the scar loosens its deep attachments, so that it can be moved more freely upon subjacent parts. It is a long time before the scar attains the vitality of the older structures, if ever it do so completely; and the larger it is, the less its power will usually be. Under the influence of scurvy or syphilis, an old scar is apt to open up again; so also, if a fresh ulcer be formed on the old cicatrix, it will take a longer time to heal than the original one.

In *structure*, cicatrices are composed of a fibro-cellular tissue, rather sparingly supplied with blood-vessels, and covered by a thin epidermic covering, usually smooth and glistening, but sometimes nodulated and rugose.

The *sensibility* of the cicatrix itself is lower than that of the skin generally, but the edges of the integument, where in contact with the cicatrix, are usually more sensitive than are the integuments on other parts of the body. When tough and irregular cicatricial bands, or "*bridles*," stretch across a part, it will usually be found that they are devoid of sensibility.

Diagnosis.—This is readily made when ulcers are seated on the skin, where no art is required to recognise a sore. On the mucous surfaces, however, it is not always easy to do so; enlarged follicles and crypts, or aphthæ, being constantly confounded with ulcers. The difficulty here proceeds from the circumstance that muco-pus may be poured out from a simply inflamed surface, or from one in which the abraded epithelium and open crypts are mistaken for ulcers.

Treatment.—In the **Local Treatment** of ulceration, the Surgeon must be guided by the special conditions presented by the ulcer, which will be described presently. But there are some points which demand attention in all cases. 1. Inflammation, when present, must be subdued; until this be done, no proper reparative action can go on. 2. Congestion and determination of blood must be prevented, by keeping the part at rest, and in such a position as will allow the ready return of blood from it. 3. Proper local applications adapted to the nature of the case, of an emollient, sedative, astringent, or stimulating character, must be employed frequently, conjoined with pressure upon, or support to, the weakened vessels of the part.

Transplantation of Cuticle.—It has long been known to Physiologists and to Surgeons, that portions of the tegumentary structures, when completely detached and transplanted to other parts of the surface of the body, occasionally retain their vitality, and grow on the surface on which they had been inserted.

The experiments of John Hunter on the transplantation of teeth, of the cock's spur, the experiments of Abernethy on the same subject, the adherence and continued growth of a freshly separated portion of the nose or chin, the transplantation, by Buenger, of a piece of the skin of the thigh on to the face for the formation of a new nose, and the observations of Walther that the button of bone removed by a trephine, if re-inserted, will contract adhesions again—all prove the fact that freshly separated parts, if immediately re-applied to a raw surface, may contract adhesions to it. But it was reserved for Reverdin to show that cuticle, if transplanted, might be employed as an agent in the cicatrisation of granulating surfaces. This observation is as interesting in its scientific aspect, as it is full of promise in its application to plastic surgery, and has already been found in many instances to be of the greatest value in facilitating the cicatrisation of large ulcerated surfaces, which could not be covered by skin in any other way. It has already been explained that the process of cicatrisation of an ulcer always takes place from and through the medium of pre-existent epidermis; and further, that the formative force necessary for the extension of the cicatrix from the edge gradually becomes weakened, and at last entirely ceases. In such cases, especially when resulting from burns, flaps of skin have occasionally been transplanted. But Reverdin has found that this is not necessary, and that all that is required is to plant small islets

of freshly separated cuticle on the granulating surface. These adhere where transplanted, and each islet forms the centre of a new process of cicatrisation, which, spreading from its edge, and coalescing with that moulded by the surrounding skin, and by the neighboring islets of transplantation, soon covers the granulating surface with a healthy cuticular cicatrix.

The process of cuticular transplantation is as follows. A piece of skin on some sound part of the body—the outside of the arm, for instance—about the size of an oat or a split pea, is pinched up with a pair of forceps, and snipped off with curved scissors. The whole thickness of the skin need not be separated, but merely the cuticle down to and including the papillary layer of the true skin, so as just to show blood. The operation, when properly performed, is almost painless. The little patch of separated skin is now placed, with the raw side downwards, on the surface of the ulcer, covered and retained in position by a strip of isinglass plaster. It is left undisturbed for about four days, at the end of which time it will be found to be adherent, and speedily becomes the centre of a new process of cicatricial action, which spreads in a gradually widening circle, until it fuses itself into the cicatricial deposit that is in process of formation from the circumference of the sore, or from other transplanted islets, and thus the cicatrix is rapidly formed.

For the success of this little operation, it is necessary that the granulating surface on to which the transplantation is made, be a healthy one; that it be not the seat of specific disease of any kind, or the result of such disease; and that the process of cicatrisation have commenced at its edges. The piece of transplanted skin should be tenderly handled, and at once applied and retained by moderate pressure. In placing it in its new position, it is well that the granulations be not bruised, so as to be made to bleed, which would be fatal to the success of the experiment. It is better to apply several small grafts of skin than one large one; each new graft acting as a centre of cicatrisation, and the process going on more rapidly from several small centres than from one large one. There is one point of importance in respect to the transplantation of cuticle, viz., that the cicatrization resulting is often weak, and the cicatrix is apt to break down much more readily than one that has not been produced by grafting.

The **Constitutional Treatment** must be carefully attended to. Unless this be done, the best regulated local plan may be employed in vain. Attention to the digestive organs, and improvement of the constitution, if it be strumous or syphilitic, will do more in these cases than any other means can accomplish. The nutrition of the patient requires due care. If he lose weight, an ulcer will not heal. It is only when the nutrition is capable of maintaining or increasing the bodily weight, that the healing process can be expected to take place.

VARIOUS FORMS OF ULCER.

When ulcers occur in the skin, as the result of non-specific disease, they may be arranged under the following heads: the Healthy; the Weak; the Indolent; the Irritable; the Inflamed; the Phagedænic or Sloughing; the Varicose; and the Hæmorrhagic. Besides these varieties, each of which is marked by distinct characteristics, various other forms of ulceration depending on specific causes, as the Syphilitic, Scrofulous, Lupoid, Cancerous, &c., are met with; all of which will be treated under their respective Chapters.

The varieties presented by ulcers are by no means dependent on local conditions merely, though these influence them greatly, but are in a great measure owing to constitutional causes. Indeed, the aspect of the ulcer, and the character of its granulations and of its discharge, are excellent indications of the state of health and of the general condition of the patient, as well as of the local disease.

Healthy or Purulent Ulcer.—This may be considered the type of the disease. It presents a circular or oval surface, slightly depressed, thickly studded with small granulations exuding laudable pus, and having a natural tendency to contract and heal. It is the object of all our treatment to bring the other forms of ulcer into this condition.

Treatment.—In the management of the healthy ulcer, the treatment should be as simple as possible; water-dressing and the pressure of a bandage usually enabling it readily to cicatrise. Sometimes, however, as has already been stated, the healing process is retarded or arrested in consequence of the extent of the ulcer. In such cases, the transplantation of cuticle will, by affording centres of cicatrisation, expedite cure. According to Lister, the application of the antiseptic gauze and protective, in the manner described in speaking of the treatment of abscess (p. 174), has also been found most efficacious in promoting the healing of ulcers of long duration. The strength of the solution of carbolic acid should be low (about 1 in 40), so as to avoid undue irritation.

Weak Ulcer not uncommonly occurs from emollient applications having been continued for too long a time in the last variety of the disease; the granulations then becoming high and flabby, with a semi-transparent appearance about them, and sometimes rise in large, exuberant, gelatinous, reddish-looking masses above the surface of the sore. These high granulations have a feeble vitality, and readily slough.

The *Treatment* of this form of ulcer consists in keeping the part elevated and carefully bandaged; and applying an astringent dressing to the sore, such as the "red-wash," or a weak solution of the sulphate of copper or of zinc, according to the following formula:—Sulphate of zinc, sixteen grains; compound tincture of lavender and spirits of rosemary, of each two drachms; water, eight ounces. This will be found a most useful application; and the granulations may be touched from time to time with nitrate of silver.

Indolent or Callous Ulcer.—This is always very chronic. It is situated upon the outer side of the lower extremity, between the ankle and calf, and most frequently occurs in men about the middle period of life. It is deep and excavated, with a flat surface, covered by irregular and badly formed granulations, exuding a thin and sanious pus, having hard, elevated, and callous edges, and presenting generally an irregular and rugged look. The surrounding integument is congested, and matted to the subjacent parts; there is usually very little subcutaneous areolar tissue about it, the skin being firmly fixed to the subjacent fascia; and it would appear as if it were in consequence of this want of a vascular substratum from which to spring, that granulations do not readily arise. There is no pain attending this ulcer, and its surface, which often attains a very large size, may usually be touched without the patient feeling it.

Treatment.—The principle of the treatment here is two-fold; to depress the edge, and to elevate the base of the sore. This is effected by pressure and stimulation conjoined. The old and very efficient plan of treatment that used to be adopted is as follows. The treatment should be commenced by rubbing the surface of the ulcer and the surrounding congested integument with nitrate of silver; a linseed-meal poultice

should then be applied for twenty-four hours, after which the sore should be properly strapped on the plan recommended by Baynton. The best plaster for this purpose is the *emplastrum saponis*, to which some of the *emplastrum resinæ* is added to make it sufficiently adhesive; this, spread upon calico, should be cut into strips sixteen or eighteen inches in length, and about an inch-and-a-half in width; the centre of the strip should then be laid smoothly on the side of the limb opposite to the sore, and the ends, being brought forward, are to be crossed obliquely over it. Strip after strip must be applied in this way, until the limb is covered for a distance of a couple of inches above and below the ulcer. If the sore be near the ankle, this joint should be included in the strapping. Each strip of plaster should be applied with an equal degree of pressure, which may often be considerable, and it should cover at least one-third of the preceding strap; the limb must then be carefully bandaged from the toes to the knee. Under this plan of treatment, the edges will subside, the surface of the sore will become florid, and granulations yielding abundant discharge will speedily spring up. Much of the success of this plan of treatment will depend upon the close attention that is paid to it. If the skin be irritable, no resin-plaster should be used, but merely the soap or lead; and the plasters should be changed at least every forty-eight hours. If the discharge be very abundant, small holes should be cut in the strips to allow it to escape. When by this mode of treatment the edges of the sore have been brought down, and the granulations sufficiently stimulated, an astringent lotion with bandaging may advantageously be substituted for the plasters. Another and more efficient method consists in—1. Painting the whole surface of the ulcer and the neighboring callous parts with ethereal solution of cantharides; 2. Applying carbolized water-dressing or oakum-poultice for a few days; 3. When granulations have sprung up, transplanting a row of skin-grafts within the edge of the sore; 4. Continuing antiseptic dressing and pressure with elastic bandages.

Irritable Ulcer is mostly met with in women about the middle period of life, especially in those of a nervous or bilious temperament. It is usually of small size, and situated about the ankles, or upon the shin. Its edges are irregular, but not elevated; the surface is greyish, covered with a thin slough, and secreting unhealthy sanious pus. Its principal characteristic is the excessive pain accompanying it, which often, by preventing sleep, disturbs seriously the general health.

In the *Treatment* of this ulcer, we must attend to the constitutional as well as to the local condition. The patient should be put upon an alterative course of medicine, with aloëtic purgatives, and some sedative at bedtime to procure rest. The mode of topical medication which I have found to succeed best, is to brush the surface of the sore and the surrounding parts from time to time with a strong solution of nitrate of silver, and then to keep emollient and sedative applications applied to it, such as lead and opium lotions. The occasional application of the nitrate of silver deadens materially the morbid sensibility of the sore, and assists its granulation.

Inflamed Ulcer.—This is characterised by much redness, heat, and swelling, of the surrounding parts, accompanied by a thick and offensive discharge, often streaked with blood; it may arise from the over-stimulation of one of the other varieties.

The *Treatment* must be locally and generally antiphlogistic. The elevated position, the application of leeches around the sore, and of cold evaporating lotions to the surface of the limb, speedily subdue the

inflammatory action ; and the healing process then takes place with great rapidity.

Sloughing Ulcer.—When not specific, this is an increased degree of the inflamed variety, usually occurring in a feeble or cachectic constitution, and generally accompanied by a good deal of irritative fever. An angry dusky red blush forms about the sore, which becomes hot and painful; the surface assumes a greyish sloughy look, the edges are sharp cut, and the ulcerative action extends rapidly.

Treatment.—This should consist in improving the general health by lessening irritation, and keeping up tone. The administration of opiates, with nourishing but unstimulating diet, should be trusted to, at the same time that the local action is subdued by rest and warm opiate lotions. When the inflammatory condition has subsided, tonics should be given internally, and a grain or two of the sulphate of copper or zinc, or a little carbolic acid, may be added to the lotion with which the sore is dressed.

The specific varieties of sloughing ulcer will be considered in the Chapters on Hospital Gangrene, &c.

Varicose Ulcer derives its chief characteristic from being complicated with, or dependent upon, a varicose condition of the veins of the leg. In this affection of the venous trunks the skin gradually undergoes degeneration, becoming brawny, of a purplish brown color, and being traversed in all directions by enlarged and tortuous cutaneous veins. The ulcer forms at one of these congested spots, by the breaking down of the already disorganised and softened tissue, producing a small irregular chasm of an unhealthy appearance, and varying much in character, being sometimes inflamed, at others irritable or sloughy, and then becoming indolent. One of the most serious effects of this ulcer is that, by penetrating into one of the dilated veins, it occasionally gives rise to very abundant hæmorrhage; the patient in the course of a few seconds losing a pint or two of blood. This hæmorrhage may be readily arrested by laying the patient on his back, elevating the limb, and compressing the bleeding point with a pledget of lint and a roller.

The *Treatment* of a varicose ulcer must have special reference to the condition of the veins that occasions it; no local applications having much effect unless the pressure of the column of blood in the dilated vessels be taken off the part. This may be done by means of a well-applied bandage, made of elastic material, or a laced or elastic stocking applied to the leg, so as to keep up uniform pressure upon the distended vessels. In some cases, the length of the column of blood may be broken by the application of a vulcanised India-rubber band below the knee. In many cases, the cicatrisation of the ulcer cannot be brought about in this way; or, if the ulcer heal, it constantly breaks open again: or hæmorrhage may occur from a ruptured vein upon its surface. Other means, which will be described in a future chapter, must then be taken for the permanent occlusion of the varicose vessels. As this procedure, however, is attended by some danger from the occasional induction of phlebitis or erysipelas, it should not be had recourse to unless the existence of one or other of the conditions just mentioned urgently calls for it.

Hæmorrhagic Ulcer.—This is a dark purplish-looking sore, which occurs in women suffering from amenorrhœa, and has a special tendency to ooze blood about the menstrual periods, whence its name. It usually partakes of the character of the irritable ulcer.

Treatment.—The hæmorrhagic ulcer requires to be treated by constitu-

tional means, having for their object the improvement of the patient's general health; with this view, the preparations of iron and of aloes are especially useful.

Ulcers and Mucous Membranes.—Various forms of ulcers occur upon the mucous membrane of the throat, rectum, and genital organs. As these, however, are commonly specific, they will be hereafter described.

When ulcers of the mucous membrane are not of a specific character they present the general appearances characteristic of the cutaneous healthy, inflamed, or weak varieties, and require the topical applications which have been described as suited to these conditions; though generally they will demand the free employment of caustics, especially of the nitrate of silver.

CHAPTER VII.

THE PROCESS OF REPAIR.

Having, in the three preceding Chapters, described certain pathological conditions in which interference with the normal nutrition of the part is a prominent feature, and having, in regard to one of these, indicated the means by which Nature repairs the injury, we have now to give a summary of the means by which injuries in general are repaired. Surgical operations generally necessitate the production of wounds, which differ in no essential respects from the incised wounds to be described in Chapter IX.; and the descriptions of the various forms of the healing process, to be now given, will be equally applicable to the effects of the Surgeon's knife and to the wounds arising from accident.

A wound, or solution of continuity, may unite in one of the following five ways:—1, by the direct growing together of two opposed surfaces—immediate union; 2, by immediate union under a scab; 3, by the union through the medium of coagulable lymph of the opposed surfaces—union by primary adhesion; 4, by the springing up from the bottom and sides of the wound of granulations which eventually become covered with an epidermic layer; and 5, by the growing together of two granulating surfaces—secondary adhesion. The first three methods of repair are confined in their action to incised and punctured wounds, the first being special to clean incisions. The last two may occur in incised wounds, if either of the three preceding ones fail, and are the only means by which contused and lacerated wounds, with some rare exceptions, have been known to heal.

1. **Immediate Union.**—The direct growing together of opposite surfaces was termed by Hunter "*Union by the First Intention:*" but most modern Surgeons extend the latter term to the union by adhesive inflammation, or primary adhesion. Wounds that unite in this way do so by the simple and direct coalescence of the opposite surfaces: and not, as Hunter supposed, by the interposition of a layer of effused blood: or, as others have imagined, by lymph poured out to form an uniting medium. Macartney pointed out the error of these doctrines, and showed that the process consists essentially in the accurate apposition of clean cut parts which unite and grow together directly in the course of a few hours, without inflammation or any of its products being required to effect the union; hence he termed it "*immediate union.*"

The *Conditions* necessary for direct union are the following:—1. A healthy constitution; 2. The perfect coaptation of the cut surfaces; 3. The exclusion of air and foreign bodies from between the sides of the wound; 4. The absence of all inflammatory action; and 5. A certain homogeneity of structure. As may readily be supposed, it is not often in surgical practice that such a simple and direct result can be obtained; though, in some of the plastic operations about the face, we succeed in securing it. It is especially in children and young people, in whom the constitution is pure and healthy, that this kind of union is to be obtained, and after operations for the cure of deformities, as hare-lip or cleft palate, rather than in those for the removal of disease. After some of the larger operations, in adults even, this kind of union may exceptionally take place. Paget has recorded a case of amputation of the breast, in which the flaps contracted immediate and direct union with the subjacent parts; and, on the patient dying of erysipelas at the end of three weeks, the union was so perfect that it was impossible to discover by microscopic examination that any inflammation had existed, or exudation-matter had been poured out. In some flap operations, the Surgeon may succeed in securing union by this means. Thus, in amputations of the thigh and arm, we occasionally find nearly the whole, or a considerable portion, of the flap united together at the expiration of about eight-and-forty hours.

Homogeneity of Structure is of essential importance in securing this kind of union. It cannot take place, for instance, between a muscular flap and the cut end of a bone. But it takes place here between soft parts corresponding in structure; and the more homogeneous these are, the more likely is direct union to occur. Hence it is easier to secure it in wounds of the face; composed as this region is of integumental structure, and cellulo-adipose and muscular tissues, nearly uniformly blended.

The advantages gained by this mode of union are, absence of inflammatory action, conservation of the vital force, and immediate and permanent closure of the cavity of the wound, all of which render the patient less liable to some of the after-consequences that attend the healing of open wounds. Further, there is no development of cicatricial tissue, and consequently no danger of subsequent contraction and deformity.

2. **Healing by Scabbing or Incrustation** consists in the direct adhesion of the lower parts and sides of a wound under a crust of dried blood, serum, hair, &c., which forms an air-tight covering. The absence of inflammation is necessary for healing by scabbing; for, if any effusion occur, the crust will be loosened, air will be admitted to the wound, and all chance of immediate union destroyed. Hence this kind of union is extremely rare in man, except in small and superficial injuries, owing to the readiness with which inflammation is set up, but it is common in the lower animals. This natural process is sometimes imitated by the Surgeon when he closes a small punctured external wound, such as that of a compound fracture, with a piece of lint dipped in blood, collodion, styptic colloid, friars' balsam, &c., under which union takes place. The essential point in obtaining union by scabbing is to secure the absence of air from the wound, as well as of any foreign body that may give rise, by irritation, to inflammatory action.

Analogous to healing by *scabbing* is the process of cure in subcutaneous wounds, as in dislocations, simple fractures, and other similar injuries, and also in the various operations of tenotomy. In these cases repair takes place without any inflammation, even though this be excited, as it sometimes is, by the injury; the reparative material, "nucleated blastema," not being an inflammatory product.

3. **Union by Adhesive Inflammation**, the "*Union by the First Intention*" of modern Surgeons, or "*Primary Adhesion*," as it is termed by Paget, is effected by the effusion of lymph between the opposed surfaces, and is more frequently obtained than the direct union. In order that it should take place, the following *conditions* are necessary:—1. That the patient's constitution be in a healthy state; 2. That the wound be closed, its sides brought into accurate apposition, and the air excluded; 3. That the interposition of all foreign bodies be carefully guarded against; 4. That the inflammation be restrained within such bounds as suffice for the production of lymph, but are insufficient for the destruction and degeneration of the latter, or the production of pus.

The **lymph**, or matter effused, presents itself to the Surgeon in two forms. One is the true healthy coagulable lymph—the *plastic* lymph of Williams, or the *fibrinous* of Paget; it is this by which union is effected. The other form has been named *aplastic* by Williams, *croupous* by Rokitansky, and *corpuscular* by Paget. This variety of lymph is met with in, and is indicative of, cachectic states of the system. It consists of a thin, clear, serous fluid, in which float corpuscles, resembling in general characters the white corpuscles of the blood. The corpuscles of this aplastic lymph are liable to degenerate into granule-cells, granular matter, and *débris*. Indeed, this corpuscular lymph is closely allied to pus. (*See* p. 160.)

These two primary forms of lymph, the fibrinous and the corpuscular, are almost always found together, but exist in various proportions in the same exudation-mass; the relative quantity of the one or the other element determining whether it shall undergo development or degeneration. Paget observes that, "the larger the proportion of fibrine in any specimen of inflammatory lymph (provided it be healthy fibrine), the greater is the likelihood of its being organised into tissue;" this preponderance of fibrine being indicative of adhesive inflammation. And "the larger the proportion of corpuscles, the greater the probability of suppuration or of some other degenerative process;" the preponderance of corpuscles being a general feature of suppurative inflammation.

The following are the steps in the process of union by adhesive inflammation in an ordinary incised wound. On the cessation of all hæmorrhage, the mouths of the divided vessels and capillaries are clogged by red corpuscles, whilst the liquor sanguinis is poured out over the denuded surfaces. The fibrine coagulates and, together with proportion of white corpuscles, adheres to the surfaces, leaving the serum to drain away. The sides of the wound having thus become "glazed" are approximated, while the layer of fibrine, being continually added to by fresh exudation, glues them together; the edges of the external incision become slightly reddened, swollen, and tender; the serum, stained somewhat by admixture with blood, continues to exude for some hours. Meanwhile, permanent union takes place by the gradual organization of the layer of fibrine into connective tissue, and all signs of inflammation subside, as the external line of incision becomes gradually covered with epithelium. The adhesive layer forms with varying rapidity on different surfaces; thus in a stump, after amputation, it will be found that the muscles, fasciæ, and areolar tissue are covered with fibrine in the course of a few hours; it is not until the third or fourth day that the subcutaneous fat becomes coated in the same way; and eight or ten days elapse before the adhesive lymph is thrown out upon the cut surface of the bone; and here it shows itself first on the medullary canal, afterwards on the cancellous texture, and lastly upon the hard bone. For the pro-

duction and organisation of this lymph a certain amount of inflammation is a necessary condition, but, as before said, it must be confined within proper limits; an inflammation that is too intense or too prolonged is fatal to the adhesive process. If too violent, the adhesive stage will be hurried into the suppurative; whilst, if it be too long continued, the development of the lymph will be interfered with; for, although inflammation is necessary for the formation of the bond of union, none is required for its organisation, or for its ultimate development into fibro-areolar tissue.

From what has been stated above, it is clear that no blood must be permitted to remain between the opposed surfaces when brought into contact with a view to their adhesion; it would simply act as an impediment to the colaescence of the fibrinous layers. Moreover, it will eventually break down, and disintegrate in the suppurative discharges excited by its presence; hence in the dressing of surgical wounds, such as stumps after amputation, and in all cases in which it is advisable to attempt to procure union by adhesive inflammation, the cut surfaces should not be brought together for a few hours, until all oozing of blood has ceased and the fibrinous layer has been thrown out.

Vascularisation of Lymph.—In lymph that undergoes development, blood-vessels are seen to make their appearance at an early period. With regard to the precise time of their formation, Dupuytren and Villermé state, from their experiments on dogs, that twenty-one days are required; and Travers, from his experiments on the frog's web, fixed the same period as that in which red blood begins to pass. In the human subject, however, the lymph on the surface of an ulcer or wound certainly appears to become vascular long before this.

How are the new vessels formed?—by development in the lymph? or by extension from surrounding parts? Hunter and Rokitansky incline to the former opinion. Travers and Quekett, who investigated the matter fully, believed that the vessels are always projected into the lymph from neighboring parts; and Paget agrees with these observers. Travers states distinctly, as the result of his observations, which are borne out by the results of the experiments of Tod, that "there is no such thing as independent vascularisation; the whole business of organisation is of and from the margin of the wound.

According to Travers, the following are the periods of development of vessels in a frog's web which has been wounded.

Up to the fourteenth day, there is stasis of blood in the vessels adjoining the wound. From the fourteenth to the twenty-first day, channels are opened in the plastic matter, at first colorless, then admitting single blood-corpuscles; from the twenty-first to the twenty-eighth day, the circulation is more active, the vessels enlarging and anastomosing; in the fifth week, transparent capillaries pass across from the colored arteries to the veins; and in the sixth week there is the formation of new vessels in loops, half-circles, &c.

The steps by which this interesting process is accomplished, are the following. At first, small lateral dilatations or pouches appear at some points on the walls of the nearest old vessels; these grow out into the plastic mass, bend towards each other, coalesce, and form loops or forks. These loops give rise to secondary vascular outgrowths; and thus the vascularisation of the lymph is completed.

Travers states that these vessels are visible, like fine striæ, before the circulation can be detected in them. A single blood-corpuscle first enters; this is followed by others, which for some time have a see-saw

or oscillating motion, progressing gradually towards the nearest vessel, by the entrance of the blood into which the circulation is completed, and becomes continuous and equable.

Degeneration of Lymph.—This has been especially studied by Paget. He observes that it may wither and harden, forming dry horny masses of vegetations; or that it may undergo fatty degeneration, and become converted into granular matter. These last two forms of degeneration are frequently met with in the coats of diseased arteries. Besides these changes, it may calcify, being replaced by an inorganic earthy material; it may undergo pigmentary changes; or it may be converted into pus.

4. **Granulation.**—In those cases in which, from the nature and situation of the wound, or in consequence of the broken state of the patient's constitution, or from some local interference with the healing process, or from some other disturbing cause, union by direct cohesion, or by adhesive inflammation, fails to be accomplished, union by "*the Second Intention*," as it is termed, occurs; and we may often see in the same wound, one portion healed by direct union, another part by adhesive inflammation, and the remainder by granulation. In such instances, the layer of lymph effused over the surface of the wound increases until it is organised into a mass of thick and ruddy granulations, whilst the serous oozing, transparent and thin at first, becomes gradually thick and opaque, and will be found by the third or fourth day to have assumed the form of pus. The inflammation has passed therefore from the adhesive to the suppurative stage. This transition is attended by a general febrile condition, the presence of which is readily detected by the thermometer, which may indicate a rise of 2°, 3°, or even 6° Fahr. With the establishment of suppuration, the pyrexia rapidly abates and disappears by the fifth or sixth day; any rise of temperature subsequent to this date cannot be due to the natural process of repair, but denotes danger from some other quarter. In other respects, healing by granulation is identical with the process of the repair of ulcers; and to that description (p. 182) the reader is referred. It must not be forgotten, however, that suppuration is by no means essential to repair by granulation. We shall find that, under certain favorable conditions, the repair of extensive and severe wounds has been accomplished with little or no formation of pus, the organisation of the lymph into fibro-cellular tissue being affected in a manner somewhat similar to that which obtains in subcutaneous injuries, such as simple fractures.

The class of injuries in which we look for union by the second intention includes the contused and lacerated wounds of all kinds, the cavities left after removal of dead bone, the raw surfaces following burns and scalds, poisoned wounds, and those incised wounds which, from the state of the patient's health, or from too violent or too prolonged inflammation, or from the interposition of blood or other foreign body, or from access of air to the wound, have failed to heal by adhesive inflammation.

5. **Union by Secondary Adhesion.**—It not unfrequently happens that, although granulations spring up over the sides of a wound, union between the opposed surfaces does not take place. We endeavor to accomplish this by bringing the granulating sides together and retaining them in that position, when they will cohere; this constitutes union by "*Secondary Adhesion.*" In some amputations, and in many plastic operations, cases of hare-lip, cleft-palate, &c., union is occasionally brought about in this manner.

On considering the five methods of union in wounds just described, it

is at once evident that the Surgeon's best endeavors should be directed towards procuring healing by one of the first three in preference to the last two, wherever practicable. The patient is not only spared the drain of a more or less prolonged suppuration, with its attendant waste of new tissue-elements, elaborated at the expense of his vital powers, but he is also saved from the subsequent dangers to life that must always be associated with an open wound. It has been remarked above, and is to be insisted on very strongly, that access of air to the denuded tissues, or the presence of a foreign body between the lips of the wound, is equally fatal to direct union, to union by scabbing, and to union by adhesive inflammation.

Circumstances affecting the Healing Process.—When any animal fluid, such as blood, serum, pus, &c., is exposed to ordinary atmospheric air, a putrefactive action is set up, with the production of various organic acids of acrid nature, quite capable, if allowed to remain in contact with a new surface, of being as irritating as any extraneous body. This property was formerly considered to be due to the action of atmospheric oxygen; but, according to Pasteur, it arises from the presence in the atmosphere of minute organic particles, the germs of various monads, bacteria, &c., the development of which in appropriate menstrua is attended with a catalytic or fermentative change in the chemical constitution of the fluid, rendering it not only locally irritating but constitutionally infective. Of the presence in the air of such floating organic matters in large quantities the observations of Tyndall and Parkes leave no doubt. Of their active agency in the production of decomposition in putrescible fluids, Lister's experiments furnish conclusive evidence.

The chief point in the management of wounds being to obtain union with the minimum of suppuration, modern Surgeons have endeavored to prevent or annihilate the decomposition of the fluids of the part in one of two ways—either by totally excluding air from the wound, or by the use of chemical agents which can act on the organic matters suspended in the air, to purify it and deprive it of some of its catalytic power. The first indication is followed out in the plan of treating wounds by hermetic sealing, by careful and accurate coaptation, by the use of collodion, styptic colloid, or lint soaked in blood to form an impervious covering, and by emptying abscesses by means of the aspirator; the second by the use of antiseptics and disinfectants, such as carbolic and sulphurous acids, the chlorides of zinc and iron, compound tincture of benzoin, spirituous and ethereal solutions, hydrated chloride of aluminium, &c.

There are other circumstances, apart from the local conditions with which we have hitherto dealt, that are not without influence on the processes of repair in wounds: the age, temperament, previous state of health and constitution of the patient, his occupation and usual mode of life, the situation in which he is placed after the receipt of the injury, and many other matters, must all more or less affect the result. Those states of the system, for instance, in which there is a tendency to the formation of corpuscular lymph, or to suppurative inflammation, such as the scrofulous or scorbutic diathesis, or where amyloid degeneration of the liver, or disease of the kidneys, &c., is present, must always militate against rapidity and perfection of cure. Habits of intemperance and over-indulgence, privation, exposure, bad sanitary and hygienic conditions, are all alike antagonistic to reparative action. These are points to which the Surgeon's attention must be directed, with the view of counteracting them as far as lies in his power by appropriate precautions and treatment.

DIVISION SECOND.

SURGICAL INJURIES.

INJURIES AFFECTING THE TISSUES GENERALLY.

CHAPTER VIII.

CONSTITUTIONAL EFFECTS OF INJURY.

An injury, if at all severe, besides its local effects, is liable to be attended by certain constitutional effects, some of which appear immediately, others after varying intervals of time.

Several of the diseased conditions which may supervene on injury, such as Gangrene, Erysipelas, Pyæmia, Tetanus, &c., will be treated of hereafter. Inflammation and its results, Suppuration and Ulceration, have been already described: and in this place we have to notice Shock, Traumatic Fever, Traumatic Delirium, and the Remote Effects of Injury.

The effects of injuries will be greatly modified, according to the condition of the patient at the time of receipt of the injury, and the circumstances in which he is placed afterwards. The remarks made at page 28, in reference to the conditions that influence the results of operations, are equally applicable to those forms of surgical injury that are the result of accident, and not inflicted by the Surgeon's knife: and to these I would refer the reader.

SHOCK.

Shock consists in a disturbance of the functions of the nervous system, whereby the harmony of action of the great organs of the body becomes deranged.

Symptoms.—On the receipt of a severe injury the sufferer becomes pale, cold, faint, and trembling; the pulse is small and fluttering; there is great mental depression and disquietude, the disturbed state of mind revealing itself in the countenance, and in feebleness or incoherence of speech and thought; the surface becomes covered with a cold sweat; there is nausea, and perhaps vomiting, and relaxation of the sphincters. In severe shock, the temperature, according to Furneaux Jordan, falls to about 97° Fahr. in the adult. In the young, the fall is less; in the aged, it is greater. Wagstaffe has met with cases in which recovery followed a fall of temperature amounting to four degrees. In fatal cases there may be a fall of as much as six degrees. These symptoms com-

monly set in immediately on the receipt of the injury. In some cases, however, there is an appreciable interval of time between the infliction of the injury and the appearance of the shock; this is more particularly the case in persons of great mental fortitude, or whose minds are actively engaged at the moment of the receipt of an injury. This condition lasts for a variable period, its duration depending on the severity and seat of the injury, on the nervous susceptibility of the patient, and on the state of his mind at the time.

CAUSES.—Shock is partly due to *mental*, partly to purely *physical* causes. Its severity and continuance are thus materially influenced by the moral condition of the patient, and by the degree and nature of his injury.

In persons of a very timid character, or of great nervous susceptibility —those who are liable to the occurrence of syncope—more especially in females and in children, a very trivial injury may produce an extreme degree of shock to the nervous system; indeed, the mere apprehension of injury may, without the occurrence of any physical lesion, give rise to all the phenomena of shock in its most intense degree. People have been actually frightened to death, without any injury having been inflicted upon them. The state of mind at the time of the receipt of the injury, influences materially its effects on the nervous system. If the patient be anxiously watching for the infliction of a wound, as waiting for the first incision in a surgical operation, all the attention is concentrated upon the coming pain; it is severely felt, and the consequent shock to the system is unusually great. If, on the other hand, the attention be diverted—if, as in the hour of battle, the feelings be roused to the highest pitch, and the mind in a state of intense excitement—a severe injury may be inflicted, and the patient may be entirely unconscious of it, feeling no pain, and experiencing no shock, perhaps not knowing that he is wounded till he sees his own blood. The severity of shock is in a great measure proportionate to the degree of pain attendant upon an injury. And, as sensibility to pain varies greatly in different individuals, so will the attendant shock.

Furneaux Jordan has pointed out that the functional activity of the nervous system has an important influence in the production of shock. In young children, he observes, whose force is developmental rather than nervous or muscular, operations and injuries are better borne than by men in the prime of life, where all organs and functions are subservient to the exercise of nerve-force. And the same occurs in persons worn by long-standing local disease, which has lowered the manifestations of vitality without impairing the integrity of the organs essential to life. "Shock," he says, "is essentially a depression or metamorphosis of nerve-force. Where nerve-force is predominant, shock also becomes predominant."

The sudden occurrence of a severe injury will, however, induce a *physical impression* independently of any mental emotion or moral influence. Thus, if a limb of one of the lower animals, as of a frog, be suddenly crushed by the blow of a hammer, the force and frequency of the heart's action immediately become considerably lessened. Here there can be no mental impression. So in man, it is found that the severity and the continuance of the shock are usually proportionate to the severity of the injury, either from its extent or from the importance of the part wounded. Thus, if the whole of a limb be torn away by a cannon-shot, or crushed by a railway-train, the shock will be severe from the extent of the mutilation, though the part injured be not immediately necessary to life; whilst, on the other hand, if a man be shot by a pistol-

bullet through the abdomen, though the extent of the injury be trifling, and merely a few drops of blood escape, yet the shock to the system will be severe, owing to the importance in the economy of the part injured. The Surgeon not unfrequently employs this fact as an accessory means of diagnosis. Thus, if a man break his leg, and at the same time strike his abdomen, and the shock be very serious and long continued, without sign of rallying, the probability is that some severe injury has been inflicted upon an internal organ; injury of the viscera occasioning greater severity and longer continuance of shock than a wound of a less vital part.

In extreme cases, the depression of power characterising shock may be so great as to terminate in death. Jordan describes two kinds of death from syncope, as being produced by shock. In cases where the impression is sudden and violent, the heart is contracted and empty, or nearly so. More frequently, however, there is a sudden arrest of the contractile power of the heart, and its cavities contain more or less partially coagulated blood. In the great majority of instances, however, *reaction* comes on, and the disturbed balance in the system is gradually restored. Not unfrequently the reaction runs beyond the limits necessary for this, and a febrile state is induced, the *traumatic fever*, which will be presently described.

PATHOLOGICAL APPEARANCES.—There are no absolutely characteristic *post mortem* appearances after death from shock. The heart is often found full of blood, especially the right auricle and ventricle, and the whole venous system is somewhat gorged, unless the patient has lost much blood from the accident. The blood was said by Hunter to remain fluid in some cases of death from shock, but this is certainly of very rare occurrence. Rigor mortis is usually well marked.

TREATMENT.—If the disturbance be chiefly mental, the patient will usually rally speedily on being spoken to in a kind and cheering manner, or on having a little wine and water, or ammonia, administered. If the shock be more severe, and be the result of considerable injury, the patient should be laid in the recumbent position, and the injured part arranged as comfortably as possible; he should be wrapped up in warm blankets, hot bottles should be applied to the feet, and friction to the hands and surface; a little warm tea, wine, and spirits and water, may be administered, provided the insensibility be not complete; if it be complete, the fluid should not be given, as it might then find its way into the larynx. In these circumstances, ammonia should be applied to the nostrils, and a stimulating enema administered. When there is much pain associated with the shock, a few drops of laudanum may advantageously be given. By such treatment as this, the energies of the nervous and vascular systems are gradually restored; and then reaction speedily comes on.

Operation during Shock.—A question of considerable importance frequently occurs in these cases; viz., whether an operation should be performed during the continuance of shock. As a general rule, it certainly should be deferred until reaction comes on, as the additional injury inflicted by the operation would increase the depression under which the patient is suffering. In some cases, however, the presence of a crushed limb appears to prolong the shock, and thus prevent the patient from rallying, notwithstanding the administration of stimulants. In these circumstances the Surgeon would be justified in operating before reaction came on. Here the administration of chloroform in moderate quantity is extremely beneficial: it exercises a sustaining influence, not only by acting as a stimulant to the nervous system, but by preventing

the pain and dread of the operation from still further depressing the vital energies. In these cases of long-continued shock, great care is required in ascertaining that there is no internal injury giving rise to the depression, but that the shock is really dependent upon the mangled state of the limb.

After the immediate effects of the shock have entirely passed away, we must adopt means to prevent the remote consequences. With this view—if the patient can bear it—blood-letting is often of essential service, and is, I think, far too much neglected at the present day. In addition to this, the patient's diet and habits of life should be carefully regulated, over-stimulation being especially avoided; his bowels should be kept freely open, and his general health attended to.

TRAUMATIC FEVER.

After the immediate effects of shock have passed off, the reaction which ensues may not pass the limits of health. In other cases however, and also in instances where the shock may have been but slight, a general febrile state arises. This febrile condition, following injuries and surgical operations, has been ably investigated and described in late years, especially by Billroth, who distinguishes between the true *traumatic fever*, occurring at an early period after the receipt of the injury, and *inflammatory secondary fever*, the result of the supervention of inflammation in the vicinity of the wound.

Traumatic Fever is, according to Billroth, the result of the absorption of decomposed materials from the surface of the wound. It generally commences on the second day, and, after increasing rapidly, remains (with remissions) at nearly the same height for nine days, and then ceases. The temperature may rise to 102° or even 104° Fahr. The pulse is generally frequent in proportion to the temperature. The decline or *defervescence* of the fever is sometimes rapid, occurring in a period varying from twenty-four to thirty-six hours; sometimes it is slow, and in these cases Billroth has noticed it to be attended by evening exacerbations.

Inflammatory Fever usually arises from inflammation of the parts in the neighborhood of the wound, and may be the result of the slow throwing off of destroyed tissues, as fascia or tendon, or of the presence of foreign bodies. It may also be produced by retained secretions in closed wounds, or by retention of the fæces and urine, or by consecutive inflammation of other organs and tissues. It may occur when there have been no appreciable symptoms of traumatic fever; or it may follow the traumatic fever. Its course, variations, and treatment have been already described in speaking of the febrile conditions consecutive on inflammation (*see* Chapter IV.).

TRAUMATIC DELIRIUM.

Traumatic Delirium not unfrequently occurs in cases of severe injury in individuals with an irritable nervous system, particularly in those who have been drinking freely before the accident, or were intoxicated at the time when it occurred. It usually comes on about the third or fourth day, but not unfrequently earlier than this; and most commonly declares itself during the night. This disease presents two distinct types, which are, in fact, different diseases—the one *inflammatory*, the other *irritative*.

In **Inflammatory Traumatic Delirium** there are a quick and bounding pulse, hot skin and head, flushed cheeks, glistening eyes, much thirst, and high febrile action generally. The delirium is usually furious; the patient shouting, singing, tossing himself about the bed, and moving the injured limb insensible to, or regardless of, pain.

The *Treatment* of this form of the disease should be depletory. Bleeding from the arm, with leeches and ice to the head, purging and low diet, will subdue it; but in many cases it is speedily fatal.

Irritative or **Nervous Traumatic Delirium** usually occurs in persons of a broken constitution, and closely resembles ordinary delirium tremens; sometimes it is preceded by a fit of an epileptiform character. In this form of the disease the pulse is quick, small, and irritable; the pupils dilated; the surface cool; the countenance pale, with an anxious haggard expression, and bedewed with a clammy sweat. The tongue is white, and there is sometimes tremor of it as well as of the hands; but this by no means invariably occurs. The delirium is usually of a muttering and suspecting character; the patient is often harassed by spectral illusions, but will answer rationally when spoken to. This form of disease is sometimes very rapidly fatal. I have known it to destroy life in cases of simple fracture in less than twelve hours.

The *Treatment* of irritative traumatic delirium consists essentially in the administration of opium until sleep is procured, or the pupil becomes contracted. For this purpose large quantities are frequently required; and the opium should be given in full doses, two grains to begin with, and repeated every second or third hour in grain doses. If there be much depression, it will usually be expedient to administer the opiate in porter, or in that stimulant to which the patient has habituated himself. The administration of the opiate should be preceded by a free purge and an aperient enema, so that all source of irritation may be removed from the intestinal canal. Hypodermic injections of morphia may be used advantageously in traumatic delirium, when the patient cannot or will not swallow. The essential point is to set the brain at rest by sleep. A strait-waiscoat is commonly necessary in all cases of traumatic delirium, in order to prevent the patient from injuring the wounded part. After sleep has been induced, the quantity of the opiate must be lessened; but it will be found necessary to continue it for some time, as there will be a tendency to the recurrence of the delirium at night.

These two forms of traumatic delirium, the inflammatory and the irritative, are often found more or less conjoined; a modification of the treatment then becomes requisite—the Surgeon depleting with one hand, and allaying irritation by opiates and giving support with the other.

REMOTE EFFECTS OF INJURY.

These may be *constitutional* or *local.*

The **Remote Constitutional Effects** of injuries are of a very varied character. In some cases, persons who have met with serious injury will be found to die suddenly, some months after apparent recovery. In others, they gradually fall out of health, the nutrition of the body appearing to become impaired, and anæmia and a cachectic state supervening. In other instances, again, the functions of the nervous system become disturbed: convulsive movements or paralytic symptoms of a slight but persistent character eventually develop themselves, and may become progressive, terminating in organic disease of the nervous centres. In these cases, the immediate influence exercised by the injury on the

nervous system seems to pass off, while a permanent impression is left. The patient never completely recovers from the effects of his injury: he is never, to use the common expression, "the same man again:" and, although his health may appear to improve from time to time, yet, on close inquiry and careful investigation, it will be found that there has been a continuous train of symptoms indicative of a disordered state of the nervous system.

These remote constitutional effects, to which attention has been directed by Hodgkin and James, often do not manifest themselves for weeks or months after the infliction of the injury. Some change appears to be induced in the condition of the blood, or in the action of the nervous system, that is incompatible with health. Perhaps, as Hodgkin supposes, the part locally injured becomes incapable of proper nutritive action, and thus a morbid poison results, in consequence of some peculiar combination of the chemical elements of the part, by which the whole system is influenced. Be this as it may, the fact remains certain, that constitutional disturbance, serious illness, or even sudden death, may supervene, as a result of a local injury, a considerable time after its infliction.

Remote Local Effects.—There can be little doubt that many structural diseases owe their origin to long antecedent injuries. The nutrition of a part may be modified to such an extent by a blow or wound inflicted upon it, as to occasion those alterations in the structure which constitute true organic disease. Thus we occasionally find, on death occurring some months after a severe injury, that extensive local mischief, usually of an inflammatory character, is disclosed, which has evidently been going on in an insidious manner from the time of the accident.

In other cases again, a blow may give rise to severe and long-continued neuralgic pains in a part, or it may be the direct occasioning cause of structural disease in bones, joints, or blood-vessels; and, lastly, it may be the origin of cancer, many cases of which can be distinctly referred to external violence.

CHAPTER IX.

INJURIES OF SOFT PARTS.

These consist of *Contusions* and *Wounds*.

CONTUSIONS.

In a **Contusion** the skin is unbroken, but there is always some laceration of the subcutaneous structures. Indeed, great disorganization of these occasionally takes place, though the skin continues entire, owing to its greater elasticity and toughness. Hence a contusion may be looked upon as being a subcutaneous lacerated wound.

In contusions there is always **extravasation** of blood into the tissues to a greater or less degree. When slight, this extravasation is termed an **ecchymosis**. The blood is not shed outwardly, accumulates under the skin in the areolar tissue, or in internal organs, presenting in the former situation the ordinary purplish-black discoloration of a bruise. The amount of blood extravasated will of course depend upon the vascularity of the part contused. The arrest of the extravasation

takes place in a great measure by the effused blood pent up amongst the tissues, coagulating over and compressing the torn vessels which have poured it forth, and thus restraining the further escape of blood from them, and allowing the ordinary process of repair of wounded vessels to take place.

CAUSES.—Contusions may result from *direct pressure*, as when a part is forcibly squeezed; from a *direct blow*, usually by a hard blunt body; or from an *indirect blow*, as when the hip-joint is contused by a person falling on his feet from a height.

Compression of the parts injured is always necessary to constitute a contusion. This compression may occur between the force on one side, and the bone as the resisting medium on the other: or the part injured may be compressed and contused between two forces in action—as when the hand is caught between two revolving wheels; or between a force in action and a passive medium—as by a wheel passing over the limb and crushing it against the ground.

DEGREES.—The amount of extravasation of blood consequent on a contusion will necessarily mainly depend upon the force employed in its production, but also to some considerable extent upon the state of health of the individual bruised. In persons out of health, with soft tissues and the blood in a low state, bruising very readily occurs. Contusions are of various degrees: they may be arranged as follows:—1, **of the Skin only**; 2, with **Extravasation into the Areolar Tissue**; 3, with **Subcutaneous Laceration of the Soft Parts**; and 4, with **Subcutaneous Disorganization of the Soft and Hard Parts.**

In the *first degree*, the blood is merely effused into the skin, producing ecchymosis or bruise; the color of which varies at different periods from purplish-red to greenish-brown, this variation being dependent upon changes that take place in the extravasated blood as it undergoes absorption.

In the *second degree* a bag of blood can often be felt fluid and fluctuating under the skin, in which state it may remain for weeks or even months without undergoing any material change, provided it be excluded from the air. In other cases it gradually becomes absorbed; or, if it communicate with the air, the bag being opened in any way, it may undergo disintegration, suppuration taking place around it, and the clots discharging through an abscess. In some cases it would appear, from the observations of P. Hewett and of Paget, that the clot resulting from extravasated blood may become organized and finally penetrated by blood-vessels. The French pathologists have described the formation of a cyst containing serous fluid in the site of the extravasated blood. These cysts are composed of a fibrous structure, but without cells, they have no distinct lining membrane, and in their interior serous or grumous fluid, composed of disintegrated blood, is found. In other cases the serous or fluid parts are absorbed, and the solid matters, forming cheesy concretions, are left behind. Lastly, extravasated blood may give rise to a sanguineous tumor, **Hæmatoma**, the blood, which may continue for months, or even years, fluid, but still not unchanged, becoming darker, treacly, and more or less disintegrated, and eventually intermixed with various products of inflammation.

In the *third and fourth degrees* of contusion the laceration and disorganization of structures usually lead to sloughing and suppuration, or to rapid gangrene of the parts, or to hæmorrhage, ending in fatal syncope; or, when the contusion is of an internal organ, this hæmorrhage may prove fatal by taking place into the serous cavities. When

the contusion is superficial, the hæmorrhage is subcutaneous, and, though abundant, rarely in sufficient quantity to influence the heart's action. In one remarkable case, however, in which a schoolmaster was convicted of manslaughter for beating a boy to death with a stick, and in which I was called to make a *post-mortem* examination, death had evidently resulted, in a great measure at least, from this cause: the subcutaneous areolar tissue of the four limbs being extensively torn away from the fasciæ, and uniformly filled with extravasated blood, whilst the internal organs were in an anæmic condition, the pulmonary vessels and the coronary arteries of the heart even being emptied of blood.

Diagnosis.—This is not always easy. The minor degrees may be mistaken for incipient gangrene, the discoloration not being very dissimilar; but the part, when simply contused, preserves its temperature and vitality. In some cases the extravasated blood has a hard circumscribed border, and is soft in the centre, which in the scalp resembles somewhat a depression in the subjacent bone.

The diagnosis of old cases of extravasation, leading to hæmatoma, from abscess or malignant disease, is not always easily made by tactile examination only; but the history of the case, exploration with a grooved needle, and examination of the contents of the tumor under the microscope, will always clear up any doubt that may exist.

Treatment.—In the first two degrees of contusion, our great object should be to excite, as speedily as possible, the absorption of the extravasated blood. Here cold applications are of especial service; lotions composed of one part of spirits of wine to eight or ten of water should be constantly applied. Leeches—commonly used in these cases—should not be applied to a bruised part; they cannot remove the blood that has already been extravasated, and often set up great irritation, which leads to suppuration. The bag of blood should never be opened, however soft and fluctuating it may feel, so long as there is any chance of procuring its absorption by discutient remedies. If once it be punctured and air be allowed to enter, putrefactive suppuration will be set up in it. But if signs of inflammation occur around it, the parts becoming red, hot, and painfully throbbing, free incisions should at once be made, the blood —already disorganised and mixed with pus—be discharged, and the cavity allowed to granulate. Purging and general depletory treatment will often promote absorption of the extravasation.

In the third and fourth degrees of contusion, it is generally useless to attempt to save the life of the injured part. Here poultices must be applied to hasten suppuration and the separation of the sloughs; the ulcer that results being treated on general principles.

Disorganising contusions of the most severe kind may be recovered from *provided there be no external wound*, even though the soft structures of the limb or part be extensively crushed, the bones comminuted, and the joints opened. It is not the subcutaneous lacerations and disorganisations that are to be dreaded; so long as the main blood-vessels of the part injured are intact, these may be recovered from. But it is the admission of air into the interior of a badly injured limb that constitutes the great danger. If this can be avoided there is little fear of undue inflammation being excited, provided proper precautions are taken; but if air be once admitted into the lacerated tissues, suppurative and sloughing action is at once set up, and the safety of the patient will be seriously imperilled. In such cases as these, amputation is usually the sole resource, unless the progress of the mischief can be arrested by the employment of the antiseptic treatment or some equally efficient plan.

The difference between the effects of a subcutaneous laceration and one accompanied by open wound is well exemplified in the cases of a "simple" and a "compound" dislocation. In the first case, although the ligaments and capsular muscles are extensively torn, often with great extravasation of blood, repair takes place without any serious trouble, often with scarcely any inflammatory action; whilst in the compound dislocation, where air has been admitted, the most extensive suppurative action necessarily ensues, and joint, limb, or life, one or other, is in great danger of being irretrievably lost.

Contusions of internal organs are always very serious, and require special treatment, according to the part that is affected, and the extent of its injury.

Strangulation of Parts.—This, when accidental, occasionally occurs as the consequence of the application of a constricting ligature or bandage, or the slipping of a tight ring over a part. In such cases, the first effect of this constriction is to prevent the return of the venous blood; this impediment to the circulation occasions serous effusion, and swelling of an œdematous character. If relief be not afforded to the circulation by the removal of the constricting body, distension of the vessels, stagnation of the blood, loss of vitality of the part, and gangrene will speedily ensue. Hence the treatment consists in at once dividing or removing the cord or ring, as the case may be. Usually this is easily done, but in some cases it is attended with no little difficulty. This especially happens when a small ring has been hurriedly put on a wrong finger, or when the penis has been drawn through a brass ring. In such cases as these the member swells greatly, and the difficulty of removing the foreign body is very considerable. The finger-ring may usually be removed by slipping a director under it, and clipping or filing it across upon this. Sometimes the following popular plan may advantageously be adopted. A strong silk thread is carefully bound round the finger as tightly as possible from the point down to the ring, and through this the free end is carried with a needle: the thread is then slowly untwisted, and the ring is thus carried upon it off the finger. Curtain or other brass rings compressing the root of the penis have been known slowly and gradually to cut through the organ without destroying its vitality or rendering the urethra impervious. But such a fortunate result is altogether the exception; in the great majority of such cases, unless the ring be speedily cut off, mortification of the organ would ensue, and might be followed, as it has been in some instances, by the death of the patient.

WOUNDS.

A wound may be defined, in the words of Wiseman, as "a solution of continuity in any part of the body, suddenly made by anything that cuts or tears, with a division of the skin."

Surgeons divide wounds into **Incised, Lacerated, Contused, Punctured**, and **Poisoned**. There are, therefore, five kinds of wounds, and, as we have already seen, five modes of healing.

INCISED WOUNDS.

Incised wounds may vary in extent from a simple superficial cut to the incision required in amputation at the hip-joint. Incised wounds are usually open, the air having free access to them; occasionally, however, when made by the Surgeon, they are subcutaneous, only communi-

cating externally by a small puncture. They may be simple, merely implicating integument or integument and muscle; or they may be complicated with injury of the larger vessels and nerves, or of important organs.

Symptoms.—In all cases incised wounds give rise to three symptoms; viz., Pain, Hæmorrhage, and Separation of the lips of the wound.

The **Pain** in an incised wound is usually of a cutting, burning, or smarting character. Dr. J. Johnson compared his own sensations to the pain produced by a stream of molten lead falling upon the part. Much depends, however, on the extent and situation of the wound; and also whether the cut has been made from the cutaneous surface inwards, or from within outwards; in the former case the pain is greater than in the latter, because the nerves are divided from the branches towards the trunk; whereas, when the cut is from within outwards, the trunks are divided first, and the terminal branches, being thus paralysed, do not feel the subsequent incision.

The amount of **Hæmorrhage** necessarily depends upon the vascularity of the part as well as on the size of the wound. The proximity of the part wounded to the centre of the circulation or to a large vessel has also a very considerable influence, different parts of the same tissue bleeding with different degrees of facility; thus the skin of the face yields when cut more blood than that of the leg. Again, the same parts will, under different states of irritation, pour out different quantities: *e. g.*, the cut surface of the tonsils has been known to bleed after their partial excision to such an extent as to cause death, although usually but a few drops are lost.

The **Separation of the Lips of the Wound** depends on the tension and the position of the parts as well as on the elasticity and vital contractility of the tissues; it is also influenced by the direction of the incision, according as this is parallel with the axis of a limb or muscle or across it. It is greatest in those parts that are naturally the most elastic or that possess the highest degree of tonicity; thus the muscles when cut retract some inches, the arteries and skin gape widely when divided, whereas in the case of ligaments or bones, no retraction takes place.

Management of Incised Wounds.—In the treatment of an incised wound, we must always endeavor to procure immediate union (p. 190) or union by primary adhesion (p. 192) between a portion, if not the whole, of the surfaces, for reasons already assigned. The probability of procuring adhesion depends greatly upon the constitution of the patient; it is a decided and most dangerous error, and as unscientific as it is dangerous, to suppose that success or failure is entirely dependent on local conditions and the management of the wound itself. In some constitutions it is impossible, under the most favorable circumstances, to obtain it. The sounder the constitution, the more readily will union by the first intention take place, and in all cases it is disposed to by the removal of all sources of irritation from the system, and by the adoption of a supporting regimen. Repair, like all other physiological processes, is attended with an expenditure of vital force directly proportioned to the extent to which plastic material is separated from the blood; hence anything approaching to a lowering plan of treatment is to be avoided, though the opposite error of over-stimulation is equally to be deprecated. Thus, in those operations, the plastic, for instance, in which it is necessary that the union be as direct as possible, the patient should be prepared by being kept for some time previously upon a diet chiefly consisting of milk and light animal food, by taking regular exercise, and by

the administration of iron; we should also look specially to the state of the digestive and urinary organs. In cases of accidental wound, we must keep the patient quiet, put him on a moderate diet, and be very cautious in the administration of stimulants, as they have a great tendency to interfere with union by the first intention. It must be borne in mind, that the great object is to limit inflammation; for if this be carried beyond what is necessary for plastic effusion, suppurative action will certainly follow. We must not lose sight, too, of the fact, that homogeneity of tissue in the opposed surfaces is essential to union by the first intention. When these are soft and uniform in structure, as in the face or perinæum, union will readily take place when the divided edges are placed in contact; but if they be dissimilar we cannot expect it; *e. g*, muscle will not adhere to cartilage, nor tendon to bone.

Local Treatment.—There is no subject in Surgery which has undergone more frequent modifications than the local treatment of wounds, from the earliest periods of which we have record. The first, and perhaps the instinctive, method of treating a wound was to close it up at once and to exclude the air by fixing upon its lips a mass of clay, of chewed leaves, or of cow or camel's dung. The admission of air was further prevented by pouring oil into it, and its putrefaction by the use of wine or balsams. At a later period in the history of our art, tents of various kinds were used, and employed up to a very recent period, in order to keep it open and thus to prevent the injurious accumulation in its cavity of discharges, which there might decompose and putrefy. The closure of the wound—the exclusion of air—the prevention of putrefaction in its discharges by the use of spirituous and stimulating antiseptics, or by facilitating the escape of the secretions, were the means employed from the earliest antiquity; without, however, that recognition of those principles involved in the use of the various medicaments and appliances adopted, which it has been reserved for a later and more scientific age to determine and elucidate.

And it is still these four great principles—the closure of the wound—the exclusion of air—the prevention of putrefaction—and the facilitation of the escape of discharges that guide us in the treatment of all wounds, however different, and in some respects improved, the means may be by which we endeavor to carry them out.

closure
exclusion air
prevention putref.

In the local treatment then of all incised wounds, there are four chief indications, viz., 1, the *Arrest of Hæmorrhage;* 2, the *Removal of Foreign Bodies;* 3, the *Coaptation of the sides of the Wound;* 4, the *Prevention of Decomposition in the Wound.* These we shall consider more in detail.

1. **Arrest of Hæmorrhage.**—If bleeding be general from the surface, it may be stopped by exposure to the air, by elevation of the wounded part, by accurate and firm coaptation, by the pressure of a well-applied bandage or of the finger over the spot, and by the use of cold or other styptics; if it be arterial, by ligature, torsion, or acupressure. In making choice of a hæmostatic, preference is to be given to one that will interfere the least with union by the first intention. Thus, amongst styptics, cold, in the shape of ice or of rags wrung out of cold water, is to be preferred to others of the same class, such as the perchloride of iron, which are all more or less caustic and irritant. Again, torsion should be employed when it can be done with safety, rather than the ligature, which, by its retention in the wound, offers an obstacle to the occurrence of primary union. In short, the simpler the remedy the better.

2. The **Removal of Foreign Bodies**, such as dirt, pieces of stone and glass, spicula of bone, coagulated blood, &c., is best effected by allowing a stream of water from a sponge or irrigator to fall upon the part, all rough handling of the wounded tissue being avoided as much as possible. Sharp and angular bits imbedded amongst the tissues should be removed by forceps. Above all, this cleansing of the wound is to be done thoroughly, and once for all; a comparatively insignificant body, if overlooked at this time, may effectually prevent adhesion by setting up suppurative action, whilst disturbance of the wound after it has been once closed, destroys the layer of effused fibrine which ought to form the bond of union.

3. The next and most important indication to fulfil, is the **Coaptation of the Opposed Surfaces** and the **Exclusion of Air** as accurately as possible.

As a general rule, the sides should not be brought together until all hæmorrhage has ceased; if, however, there be but slight oozing, this may be arrested by the approximation, and the pressure thus exercised on the bleeding vessels. Before doing so, however, the whole extent of the wound should be washed with an antiseptic solution, to obviate as much as possible subsequent decomposition. For this purpose a watery solution of carbolic acid (1 to 40) is the best; some prefer a lotion (10 gr. to ℥i) of chloride of zinc, or sulphurous acid, or ether. The surfaces should then be gently brought together, from behind forwards, so as to thoroughly exclude all air and superfluous moisture from the deeper portions of the wound, the skin margin being the last to be adjusted; due attention should at the same time be paid to relaxing the parts by position, so that there may be no gaping of the lips nor tension on the sides of the wound.

The arrangement of the parts should be such that there may be a ready escape for the serous oozing, which must necessarily ensue in wounds that do not at once adhere throughout their whole extent. This should be allowed to take place from what will be eventually the most dependent point of the wound; and where ligatures have been used, the threads should be brought out at the same spot. The ligatures, if thick and numerous, will serve as a conduit or drain for the fluids that are poured out by the cut surfaces. But in addition to these, and in all cases in which they are cut short, it may be well to insert a "*drainage-tube*" into the wound, and retain it there from 48 hours to several days, according to the amount and character of the discharge. The value of the drainage-tube in preventing the accumulation of blood, of bloody serum, and of pus, cannot be over-estimated. It is the greatest safeguard we have against decomposition of fluids and their accumulation in the wound, and this more than any other means favors cohesion of its opposite sides, and secures the patient from all danger of septic contamination. Its use should never be omitted, especially if the wound be deep and irregular, or if there be danger of bagging under a flap. For the purpose of keeping all in position, *sutures*, *plasters*, and *bandages* are employed.

Sutures should be used as little as possible. They are painful in their introduction, irritating in their presence, and often troublesome as well as painful in their removal. They also tend to favor bagging, by causing superficial union, whilst the deeper parts still gape. With all their disadvantages, they must, however, be employed when there is more tendency to gaping than can be overcome by position or plasters. Threads of well-annealed silver or iron wire, of various degrees of stout-

ness, are now more generally used than those of silk, as they are less irritating, are incapable of imbibing the secretions of the wound, and, when once adjusted, keep the form first given to them. In cases, however, where the sutures are only retained for a day or two, it is not of much moment which material is used; if it be silk, it should be that known as dentists' or twisted silk, well waxed; the thickness should vary with the nature and situation of the injury. Thus, in wounds of the limbs, where much traction may be expected, the suture should be thick; whilst in those cases in which it is of importance that as little deformity as possible should be left, *e. g.*, in plastic operations and in wounds about the face, it should consist of the finest material compatible with strength. The threads are introduced by means of needles of different curves; in some instances it is convenient to have them set in a handle with the eye near the point (nævus-needle), instead of in the ordinary position. For metallic threads a slight modification of the ordinary needle is required, to prevent the wire when doubled back after passing through the eye from offering any obstruction to its passage through the tissues; "tubular" needles are also employed for this purpose.

The modes of applying sutures are various; but the one most commonly employed in all cases involving the integument, is the **interrupted**, which consists of the introduction of as many single stitches, from an inch to an inch and a half apart, as may be necessary to close the opening. In longitudinal wounds, the first stitch should be inserted in the centre; but if there be any angles, as must be the case after crucial incisions, the extremities should be first closed; if more than one suture be required, they should all be in position before the first is fastened. The fastening is effected in the case of the silk thread by tying the reef-knot, and in that of the wire, by twisting the ends round one another; in both instances, the ends are cut off short. The knot or twist must not lie over the line of incision, but on one or other side of it. The time that the suture should be allowed to remain, must depend greatly on the nature and progress of the wound; as a rule, from 24 to 48 hours is sufficient; by that time they will have answered their purpose of procuring union of the opposed surfaces. Every minute they are left in after this is detrimental to adhesion, and is attended with the risk of the excitation of undue reaction. The wire suture may, however, in some cases be advantageously retained for a much longer period, even for six, eight, or ten days; but at last even this will produce ulceration. In withdrawing sutures, the knot or twist should be raised by forceps, and the thread divided on one side of it; gentle traction on the knot, the forefinger of the other hand being placed close near the point of exit in the skin, to prevent disturbance of the newly formed lymph, will then suffice to draw the suture out. When wire has been used, the bends in it should be straightened as much as possible before pulling them out.

In the **continuous suture**, or glover's stitch, the thread is carried on from stitch to stitch, instead of being detached from the needle, and fastened off as in the interrupted suture. The stitches are placed nearer together, so that the adjustment of the edges is more intimate. Either metallic or silk thread can be employed; in withdrawing it, each loop must be divided, and each piece removed separately, as in the common stitch. This form of suture is not very often employed, but it may be used in simple incisions of some length, such as those that are left after

the removal of tumors in the trunk, or are required in ovariotomy, in wounds of the intestines, etc.

The **quilled suture** is employed where the sides of a deep longitudinal wound are required to be kept in contact throughout, as in ruptured perinæum. It consists of a series of double interrupted sutures of stout silk or whipcord passed deeply, through the loops of which, that hang out on one side of the wound, is passed a piece of bougie, or quill, whilst the ends of the thread are tightly tied over a similar cylinder on the opposite side. The stitches should enter and emerge about half an inch from the line of incision, and be so placed that the cylinders when *in situ* lie parallel to one another. Fine interrupted sutures may be used in addition, to connect the superficial parts.

The **twisted** or **figure-of-8 suture** is very commonly employed in surgery. A slender pin, made of soft iron, with a steel point, is introduced through each lip of the wound, at a distance of about one-third of an inch from the margins; and, whilst the latter are held in contact, a piece of silk twist is passed in a figure-of-eight round the pin, care being taken not to draw it too tight, nor to compress the soft parts between the needle and the thread, lest sloughing ensue. The projecting ends of the pin are now cut off with pliers, and the skin beneath them protected with plaster. This suture is invariably used in the treatment of hare-lip; but it is of great service wherever the lips of the wound are very vascular; it has the advantage, likewise, of taking the tension off the suture, and transferring it to the tissues themselves, so that it is less likely to cut its way out than the interrupted suture. The pin may be withdrawn in about forty-eight hours.

The **serrefine** (Fig. 80), a twisted coil of silver wire, with the extremities terminating in small hooks, by means of which the edges are kept in contact, may be had recourse to in cases where very accurate union of the lips of a wound is required, as in cuts about the face, and the like. The inventor, Vidal de Cassis, recommends a large number to be used, and that they should be allowed to remain in twenty-four hours. They are made in sizes one to six, the latter being the largest.

Fig. 80.—The Serrefine.

Plasters are of various kinds, those most commonly employed being the resin, soap, and isinglass plasters. Each of them possesses peculiar properties, fitting it for use in particular cases. The resin plaster has the advantage of being most adhesive, and of not being readily loosened by discharge; but, on the other hand, it is irritating, sticky, difficult to remove, and, in consequence of the lead that it contains, leaves a dirty-looking incrustation behind it. The soap plaster is less irritating, but at the same time less adhesive; it is consequently not much used in the management of wounds. The isinglass plaster is doubtless the most cleanly and less irritating of all, and, being transparent, permits the Surgeon to see what is taking place beneath it; but it is readily loosened by the discharges, and is apt to run into a cord.

Whichever variety is used, the plaster should be cut into strips of convenient length and breadth, and heated by being passed through hot water. All superfluous hair having been removed, and the surface well dried, each strip should be laid down evenly between the points of suture, when these have been used, so as to compress and support each side of the wound with equal force; the longer the strip, the firmer will be its holding, and the less likely it will be to be prematurely loosened. In removing the plaster, both ends should be raised at the same time towards the wound, and the strip should then be taken off without either

lip of the wound being unduly dragged upon. The strips should be allowed to remain undisturbed as long as possible, and each one replaced before the next is removed.

In a certain class of incised wounds, of limited extent, where the edges can be accurately adapted to one another by sutures or plaster, or by the combination of both, and when but little oozing is to be expected, very fair union by scabbing may be looked for without any further dressings. Indeed, some Surgeons prefer to treat such extensive wounds as amputation-stumps in this way. The formation of the scab, however, may be hastened and imitated by the use of **Collodion**, painted freely over the line of the incision with a camel's hair brush, after the surface has been well dried, or of **Styptic Colloid**, which has the further advantage of being hæmostatic and antiseptic. The film thus formed may be further strengthened by some shreds of charpie or fine lint. A second or third application of the collodion or styptic colloid will be required, if the crust show any sign of becoming detached; otherwise it may be allowed to remain until it separates of itself, which it usually does in the course of a few days. Similarly, a piece of lint soaked in blood, or in compound tincture of benzoin, may be applied over the wound, and under it, direct adhesion by a process analogous to that of scabbing may take place.

When the wound is more extensive, and the simple measures just described are impracticable, the edges are to be covered with a fold of lint moistened in tepid water. to which carbolic acid has been added in the proportion of 1 to 100. over which is laid a piece of oiled silk, or other impermeable material, a trifle larger in every direction than the lint (water-dressing), whilst the whole surface in the neighborhood is kept cool by a piece of wet lint, or, if the inflammation threaten to run high, by irrigation. Some Surgeons use the best olive oil as an application in preference to water, as being more soothing, less heating, and less prone to promote decomposition ; by others, a solution of sulphurous acid is recommended (1 part of a saturated solution to 7 or 8 of water). Carded oakum in place of lint has the advantage of being highly absorbent, cleanly, and antiseptic, but it is of greater service in suppurating wounds than in recent ones. The first dressings should be left unchanged for two or three days ; the sutures may then be removed, and the plasters readjusted as they become loosened, care being taken to support the sides whilst doing so. One important point in the management of every wound, is to maintain, as much as possible, the injured structures in a state of *rest*. This is to be done by position, the Surgeon refraining from disturbing the parts unnecessarily, using his eye rather than his hand to judge of the progress made, and by the use of compresses and bandages. *Compresses* of soft linen or lint should be so disposed as to aid in keeping the sides in apposition, whilst they prevent the collection of fluids in the recesses of the wound; the *bandages* should be applied over them so as to exert a steady well-regulated pressure, but not to impede the free circulation of the blood in the part.

4. The next great point in the treatment of wounds is the **prevention of decomposition**. The decomposition of the fluids of a wound is due to their infection by septic matter. In some cases it is possible that such septic infection may be the result of morbid states of the blood or tissues of the patient. But these instances of self-infection are rare and exceptional. In other instances, again, the decomposition of the wound is predisposed to, though not actually determined, by the state of the patient's constitution. In the vast majority of cases—when it occurs—

it is the direct result of the infection of the wound from without. The decomposition of the fluids of a wound, in whatever way occasioned, is a bar to its healing by "the first intention;" it is productive of unhealthy suppuration—certainly of delay—possibly of constitutional contamination and general blood-poisoning.

The infection of wounds takes place through the medium of the air. If a wound be wholly subcutaneous, without any breach of the superimposed integument, through which the air can gain entry, no infection can take place in it. Hence the difference between the liability to septic diseases—to those diseases such as pyæmia, hospital gangrene, &c.—of a person who has sustained a subcutaneous wound, however extensive, as, for instance, the comminuted fracture of a bone, with much laceration of soft parts, and of one who has suffered from an open wound of a corresponding character—as a compound fracture. The question necessarily arises, How does the air infect? And this great question includes three minor ones, viz, Is the air itself the infecting material? If not, is it the medium or the vehicle of the conveyance of infection? And if it be the vehicle, does the infection occur from gases or by solid particles carried in the air?

The answer to the first question involves the whole subject of *auto-* and *hetero-genesis*, of spontaneous generation and that by germs—a subject that has occupied the attention and has exercised the ingenuity of scientific men of all ages and all countries, from the time of Aristotle, and which appears to be as far from its ultimate solution now as it was when he wrote "De Animalium Generatione." The discussion of this subject would be altogether out of place here; and for its consideration I must refer the reader to the writings of Pasteur, Lister, Bastian, and Tyndall.

So far as our present purpose is concerned, it may be sufficient to state that Lister has shown conclusively that putrescible fluids, such as urine and milk, may be exposed for months to the action of filtered air without undergoing decomposition, and that air deprived of extraneous bodies is not *per se*, and independently of other agents or conditions, sufficient to occasion decomposition. That absolutely pure air may not be the cause of decomposition in healthy but putrescible animal fluids, appears to be established by these observations. But it has not been proved, and it by no means follows, that the decomposition of morbid secretions, such as are generated by inflamed tissues, or developed in diseased conditions of the blood, may not be hastened by exposure to the oxidising influence of even perfectly pure air. In fact, decompositions of pus as manifested by the presence of Bacteria will take place in certain conditions, as in subperiosteal abscess and elsewhere, in places into which no air has been admitted or is admissible. That the spontaneous development of putrescent sanies or pus in certain states of the system may take place on the surface of wounds, there can be no doubt; and the action even of chemically and microscopically pure air on such fluids, the product of diseased tissues, and already, *ab origine*, putrescent, cannot be other than to favor and hasten decomposition. But although it must be admitted that the decomposition of sanies and pus formed in diseased tissues in unhealthy constitutions may be hastened, and probably developed, by air that is perfectly pure, the question is in reality one of scientific and not of practical interest. For air is only found to be chemically and microscopically pure when it is artificially prepared for the purpose of experiment. In nature such a condition of

the atmosphere does not exist—at least not within reach of the habitations of man.

Wherever man dwells, there the air becomes contaminated; and the amount of contamination in the air will, *cæteris paribus*, be in the ratio of the density of the population on any given space. And it is as a medium or vehicle for the application of contaminating agents, generated by man and animals, and which, when applied to open wounds, and mixed with their secretions, act as ferments and favorers of putrefaction, that ordinary atmospheric air acts so injuriously on wounds.

These contaminations contained in the atmosphere, as the result of human agencies, are of two kinds—gaseous and solid. So far as we know, the gases that are admixed with and deteriorate atmospheric air in its value for the purposes of respiration, do not act injuriously on wounds or on the secretions from injured surfaces.

We must, therefore, look to the solid particles as the true infecting agents, conveyed to and implanted on the surface of open wounds by the air, in which they float suspended in countless myriads. Their existence in a state of suspension in the air has been proved incontestably by the observations of Tyndall, and it has been shown that their nature will vary in different localities, according to the composition of the materials from which they emanate. Their composition will necessarily vary in private houses and in public buildings, in factories and in shops, in barracks and in hospitals. They are inorganic and organic. The organic particles may be living or dead. But though dead, they may still be capable of infecting an open wound on which they are deposited. The epithelium of desquamating scarlatina, and the dried scab of the small-pox pustule, though undoubtedly dead organic matter, are in the highest degree infective. If this is so with the products of these diseases, we cannot suppose it is otherwise with the organic emanations from erysipelas, pyæmia, or hospital gangrene.

In addition to organic atmospheric dust, by which wounds may be infected, there are other forms of organic matter floating in the atmosphere of all sick rooms and hospital wards tenanted by patients suffering from acute febrile wasting diseases, whether of a septic type or not, which if not actually capable of infecting, can scarcely be productive of healthy action on wounds exposed to their influence. The volumes of aqueous vapor given off by a patient's body in the sweating stages of the pyæmic paroxysm are charged with organic matters, as the odor alone will tell us, in a state of decomposition. The breath is loaded with aqueous vapor, holding salts and other matters in solution.[1] These are widely diffused through the air of wards or rooms, and may be equally productive of local infective, as they undoubtedly are of constitutional, disease. Who would willingly expose even a cut finger to the emanations of pyæmia or the fœtor of phagedæna?—and yet hospital authorities make but insufficient provision for the separation of the most seriously wounded from patients laboring under these foul and filth-begotten diseases.

But, setting aside the consideration of these impurities in the shape of vapors, gases and fœtors, with the nature and operations of which we

[1] The composition of these excreta can nearly be determined by condensing the breath on a glass, collecting the resulting drops of fluid and examining them under the microscope, when they will be found to abound in crystals of salts, epithelium scales, and organic particles.

are but imperfectly acquainted, we may state the following points in regard to infective atmospheric dust as established.[1]

1. Air that is absolutely pure, chemically, optically, and mechanically, cannot infect a wound.

2. There is no evidence that traumatic infection can occur from chemical impurities in the air, such as gases.

3. There is no evidence that it can occur from the admixture of organic aqueous vapor with the air.

4. The infection of wounds is due to the implantation on them, or in the secretions adherent to their surfaces, of solid organic particles suspended in the air.

5. The air of rooms and of all inhabited places is loaded with solid particles in the form of impalpable dust, a great portion of which is organic. The quantity is so great, that under a powerful beam of electric light the air appears as a semi-solid rather than as a gas (Tyndall).

6. The organic constituents of this dust vary in quality in different localities. No air is absolutely free. It is found in the purest mountain air (White), and is present in sea-air (Rattray).

7. Its composition depends on the locality in which it is found, and the sources from which it emanates. Thus, on board ship, besides consisting of various solid impurities, of vegetable and animal origin, from the stores, wood, cordage, whitewash, &c., it contains impurities thrown off by the skin and lungs of the crew (Rattray). In barracks and military hospitals, the air contains floating particles of epithelium from the skin and mouth (Parkes)

8. This organic dust does not necessarily by any means consist of dead materials. It has been found to be largely composed of the spores of fungi, the largest portions of which are living and capable of growth and development. Bacterial matter has also been found in dry dust (Cunningham).

9. Hospital and sick room air contains large quantities of floating epithelium from the skin and mouth, disintegrating pus-cells and putrefying organic matter (Parkes), dried constituents of pus, and possibly very small living organisms (Billroth)—bacteria in abundance (Lund).

10. The amount of impurity will depend upon the number of the patients and the nature of the cases in any given ward. Over-crowding of wounded patients pollutes the air with the emanations from the wounds. If the proportion of wounded in relation to the size of the ward exceed a certain ratio, then infection of the wounds infallibly occurs:—"The infection of the whole body comes from the wound" (Billroth). The ratio of the wounded to the size of a given ward may be calculated; and if it exceed a certain proportion, infection of wounds will be induced, and septic disease will be developed, and their occurrence may with absolute certainty be predicted ("Hospitalism," p. 62).

In the treatment of all wounds, whether surgical or accidental, the first points to be considered are the hygienic conditions which surround the patient, and those to which the wound is exposed. The more favorable the general hygienic conditions surrounding the patient, *cæteris paribus*, the more favorable will be the prospect of the wound towards recovery. Every well known sanitary regulation as to diet, ventilation, temperature, and clothing should be adopted with this view.

But the local hygienic conditions—those which directly and immediately affect the wound itself—are of still greater consequence. The

[1] For details, *vide* "Hospitalism," &c., pp. 64 *et seq.*

Fomites = infections

wound is an open portal through which the most deadly influences may readily gain entry into the stronghold of life. Hence it must be jealously and keenly watched. In private practice, and in the open country, fewer precautions may be necessary than in the wards of hospitals or the crowded habitations of a large town. Were hospitals situated, constructed, and managed in accordance with well known and universally received hygienic rules, much of the labor, and the greater part of the anxiety, of the Surgeon would be spared; for the healing of a wound under favorable hygienic circumstances is a simple affair—which, after the first needful attentions have been bestowed upon it, after the bleeding has been arrested, the surfaces cleaned, brought and held together—may usually be left to Nature and to cleanliness. But the labor of the Surgeon is expended on, and his mind is anxiously directed to, the adoption of means to prevent infection of the wound; and, if that infection have taken place, to prevent the local evil from contaminating the general system. It is by infection that simple wounds, instead of uniting by the first intention, become suppurating chasms. It is by infection that putrefactive decomposition is set up on the suppurating surfaces. It is by putrefaction that the foul and sloughy surface becomes the central point whence erysipelas spreads and pyæmia invades the system.

Keep out infection, and local destruction, followed by constitutional contamination, is averted. Admit it, and every evil, to those most terrible of all, hospital gangrene, and pyæmia, may occur.

The local hygienic precautions to be adopted consist in the most scrupulous attention to cleanliness: the exposure of the wound to an atmosphere unpolluted by the reek of the out-patients' rooms, or the fœtor of the dead-house; sponges only to be used in the operating theatre; frequently renewed and purified by carbolic acid; the instruments, dressings, and fingers clean, and, when used for the living, never allowed to come into contact with the dead; and, above all, never to be contaminated by putrescent matters. The clothes, the bedding, all those "*fomites*," which may harbor infective particles, should be carefully attended to. The more special method of purification of dressings, and of preventing decomposition in the fluids of the wound, must be effected by the use of antiseptics.

The **prevention of decomposition** in the wound may be effected in two ways, which are, indeed, usually combined, viz.: 1. By the employment of antiseptics, of which a vast number have been employed in surgical practice—from the wine and balm of the ancient to the carbolic acid of the modern Surgeon; and 2. By securing free exit to the secretions of the wounded surfaces, either by dressing the wound open from the first, by closing it and keeping one corner open by a tent, or by the drainage-tube.

Antiseptics

drainage

The Antiseptic Treatment of Wounds.—Allusion has already been made at p. 195 to the theory founded on Pasteur's observations and experiments which attributes suppuration, in the majority of cases, to the putrefactive fermentation set up in an animal fluid by the development in it of organisms carried into it as germs floating through the atmosphere, and not spontaneously developed in it by any change taking place in the tissues or fluids of the part independently of such impregnation. According to the "Germ-Theory," as applied to wounds, it necessarily follows that, if the impregnating germs can be rigidly excluded from a wound, all those suppurative actions that are dependent upon the implantation of new organisms on a raw surface will be prevented. This may evidently be accomplished in two ways: either by completely excluding all air from a wound, and thus preventing the

intrusion of the germs carried by it; or else by destroying the germs floating in the air around the wound by an antiseptic vapor, as of carbolic acid, and thus admitting to the surface of the wound absolutely pure air that has been entirely freed from all septic matters. It is important to bear these points in mind, and to recollect that in accordance with this theory the exclusion of atmospheric air from a wound is by no means necessary; that it does not act injuriously of itself, but simply as a vehicle of septic germs; and that, if these be destroyed by chemical action or removed by filtration, and the air thus rendered surgically pure, so far as organic or septic intermixture is concerned, it may be freely admitted. Taking this germ-theory as his starting-point, Lister has founded on it a plan of treatment in wounds, as novel as it is scientific and ingenious, which is known as the "Antiseptic Method." The principle on which this treatment is founded consists in protecting the wound in such a manner during the process of its healing, that no organic germs floating in the air are admitted to it. This principle is carried out in two ways—by covering the wound with antiseptic dressings, and by surrounding it with an antiseptic atmosphere—the active agent for both purposes being carbolic acid.

It is claimed for this method that, when it has been thoroughly carried out, union will take place, even in extensive contused and lacerated wounds, without the formation of a single drop of pus, and without the occurrence of any general febrile reaction. The principle on which this method of treatment is founded, is, as is well known, disputed by Pouchet, Charlton Bastian, and other scientific men, who advocate the doctrine of spontaneous generation. It would be altogether foreign to the scope of this work to enter into this discussion; and whether the germ-theory be correct or not, matters perhaps little to the practical Surgeon, for there can be no doubt that the decomposition of fluids in wounds, and the consequent suppuration, are greatly favored by the admission of impure air; and that any treatment which has for its basis the exclusion of impure air and the prevention or arrest of decomposition of the animal fluids by an antiseptic body, such as carbolic acid, must be theoretically advantageous, and based on sound principles of practice. If the admission of air into a wound were the *sole* cause of its suppuration, whether that result be the consequences of the chemical constitution of the air, or of the introduction into the wound through its medium of organic particles that produce a fermentative action in the fluid and tissues in which they are deposited, there can be no doubt that any method of treatment having for its object the exclusion of the air and the destruction of these organic particles ought to prevent absolutely the formation of pus in the wound. But, as we know that suppuration may take place in situations into which no air has been admitted, we cannot look upon the atmosphere as being the sole occasioning cause of this action, however much it may favor it; and it must be referred in such cases to the influence of other agencies, amongst which certain morbid conditions of the blood, constitutional derangement of the patient, and intensity of inflammation are the more important and direct.

It is undoubtedly these disturbing influences that prevent the complete success of the "Antiseptic Method" in a certain number of cases. Theoretically it is perfect; in practice its success is not constant. It would be successful in all cases, were the healing of a wound a purely local act under the sole influence of local conditions of tissue and of treatment. But this is far from being the case. The repair of a wound is a process that is materially influenced for good or for evil by the state of the

patient's constitution. When that is healthy and pure, the wound will readily heal under any favorable local conditions, and under none more readily than under the antiseptic method. When the blood is vitiated and the constitution depraved, no mere local method of treatment can be trusted to as an infallible preventive of local morbid action. But even in such unfavorable cases as these, where suppuration and sloughing are rather the consequences of a bad constitutional than of a morbid local condition, the antiseptic method, by lessening the tendency to decomposition and to putrefactive or fermentative changes in the wound, and by rapidly removing and destroying noxious materials and effluvia, will do more than any other plan of treatment to limit the morbid local action that results from the continued presence in and around the wound of septic matter, and to prevent those grave constitutional sequences that inevitably result from its absorption into the system, and thus to avert the various forms of blood-poisoning that are often occasioned by wounds in an unclean, suppurating, or sloughy state.

It must be remembered that the employment of antiseptics has no effect on two of the most important cases of suppuration in wounds, viz., tension and the irritation of movement; and, moreover, it may itself be a cause of suppuration if too concentrated an antiseptic be allowed for any length of time to remain in actual contact with the raw surface. A tight stitch may cause inflammation and suppuration as readily under antiseptic dressing as under any other mode of treatment. If free exit be not provided for the necessary serous discharge which flows from the surface of a wound during the first twenty-four or thirty-six hours, its accumulation will give rise to tension, and suppuration will certainly follow, although the pus may be perfectly free from any odor of decomposition. Drainage of the wound is, therefore, an essential part of the antiseptic treatment. Rough handling, unnecessary disturbance, or the unavoidable movements due to the situation of some wounds, will also give rise to the formation of pus, whatever mode of dressings be employed.

As the "germ-theory" constitutes the basis of the antiseptic method, Lister very justly contends that success in its practice can only be looked for by attention to minutiæ and details, and extreme care in manipulation. One single septic germ making its way to the surface of the wound would, in accordance with this theory, be sufficient to light up all the mischief which it is the object of this method to avert.

We have already (p. 210 *et seq.*) discussed the principles on which the antiseptic method is founded. The details have been most ingeniously varied from time to time by Lister. Any one who understands the principles on which it is founded can have no great difficulty in carrying it out on the following plan, which more or less modified is in accordance with Lister's most recent views on the subject.

Arterial hæmorrhage, when present, is controlled by torsion, or by tying the vessels with carbolised catgut ligatures. These are prepared by soaking fine catgut for some weeks in an emulsion formed by adding one part of pure **carbolic acid**, deliquesced by the addition of water, to five parts of olive-oil. The ligatures are cut off short, and allowed to remain in the wound to become absorbed by the surrounding tissues. Oozing of blood is to be checked by cold carbolised water. Supposing the wound to be the result of accident, its whole extent, even to the most remote recesses, is to be thoroughly mopped or syringed out with a watery solution of the acid. If the wound be irregular this is best done by means of a syringe with a piece of soft India-rubber tubing on its

nozzle. The tubing is stiff enough to penetrate any existing cavity in the wound, but not so stiff as to force a way for itself. Care must be taken in injecting the wound, not to squeeze the lips together so as to get up high pressure in its cavity, or the cellular tissue in the neighborhood may become injected with the solution of carbolic acid, and unpleasant inflammation may result. If the wound be fresh, the solution need not be stronger than 1 to 40, but if some hours have passed it is safer to use a solution of 1 in 20. The whole of the parts which will be covered by the dressing should be well washed with a solution of 1 in 20. If the wound be on the hand or foot, great care must be taken to clean the nails and between the digits. If on the head, the hair must be cut, and here it is safer to oil what remains with carbolised oil, 1 to 10. Any sutures that may be required should be metallic, or of silk twist steeped in beeswax melted with one-tenth of carbolic acid, the needle and thread being passed through a watery solution of carbolic acid (1 to 40) before being used. The dressing from the time the injection is finished should be conducted under a spray of carbolic acid and water (1 to 40). By means of the spray of 1 to 40 carbolic acid solution, thrown by an anæsthetic spray-apparatus or some modification of it, the wound is surrounded by a carbolised atmosphere in which none of the solid particles which cause decomposition can retain their activity; in other words, no germs can live. If the wound be very large so that the cloud of spray from one apparatus does not completely cover it, two must be used. If from any reason the spray should cease, the wound must be covered with a "guard" consisting of a piece of linen rag free from holes, soaked in carbolic acid and water (1 to 40), which should be in constant readiness during any dressing or operation. In wounds produced by operations, the syringing and mopping out with carbolised water is unnecessary, as the whole operation is performed under the spray. All the instruments should be put in a basin of carbolic acid and water (1 to 40), and taken out as required, and put back again if they are likely to be wanted a second time during the operation. The sponges used during the operation must be washed in a 1 to 40 solution of carbolic acid; and in hospital practice it is advisable to keep them always ready in a bath of the solution. After an operation, the meshes of the sponges always are more or less filled with coagulated fibrine, which no washing will get out. To clean sponges thoroughly, Lister recommends that they should be put in a basin of simple water for some days, till the decomposing fibrine emits a powerful smell; then washed thoroughly with water, and put to soak in a bath of 1 to 20 solution of carbolic acid.

Before beginning the operation, the Surgeon must thoroughly soak his hands in a 1 to 40 solution of carbolic acid; and when practicable, it is advisable to keep a rag soaked in the same lotion applied, for some hours before the operation, to the area afterwards to be covered by the dressing. In all cases, the whole of the part to be operated on must be carefully washed with 1 in 20 solution before commencing the performance. If old sinuses be implicated in the operation wound, they must be injected with chloride of zinc (40 gr. to an ounce) after the operation, and the whole wound washed out with carbolic acid lotion. If the sinuses be numerous, it is, perhaps, safer to wash the whole wound out with chloride of zinc lotion, the good effects of which were pointed out by Campbell de Morgan many years ago. Sinuses should be injected before the operation, as there is some danger of rupturing their walls, and if the chloride of zinc lotion should thus become injected into the cellular tissue, the most extensive and dangerous sloughing may result. In all cases of wound,

whether resulting from accident or operation, drainage forms an essential part of the antiseptic system of treatment. The irritation of the antiseptic, applied to the raw surface, increases considerably the flow of the natural serous discharge during the first twenty-four or thirty-six hours. There are no ligatures to form a drain for it, and the edges of the wound are rather firmly pressed together by the dressing. It is necessary, therefore, to provide for the exit of the discharge by means of India-rubber drainage tubes. One or more must be inserted to the very bottom of the wound, and the edges of the skin may then be brought together as closely as possible, a continuous suture even being used if the Surgeon prefer it. The tubes must be rendered antiseptic, by being kept for about twenty-four hours in a 1 to 20 solution of the acid. They should be cut off level with the surface, and to prevent them from slipping into the wound, a carbolised silk thread should be attached to their superficial ends. The tubes must vary in size and number with the extent and nature of the wound, and must be brought to the surface at the most convenient and dependent parts. It must be remembered that these tubes, being usually made of vulcanised India-rubber, contain a considerable amount of sulphur. They will, therefore, often impart a peculiar smell to the discharge, and blacken silver stitches or plasters in their neighborhood, and so falsely suggest that decomposition has taken place. The drainage-tubes should not be moved for the first two days, by which time they will have formed a track for themselves, and can be readily re-introduced if necessary. Sometimes they can be completely removed on the third day; but usually it is safer merely to shorten them by cutting off a piece at each dressing till they become reduced to about half an inch in length.

In all cases, it is better from the beginning to protect the raw surface and edges of the wound as far as possible from any direct contact with the carbolic acid in the dressings, which would infallibly cause sufficient irritation to produce suppuration. The small quantity of carbolic acid left in the wound when it is closed, is so temporary in its action as scarcely to require consideration. It is partly washed away by the serous discharge and partly absorbed, so that probably in a few hours, or perhaps less, the deep parts of the wound are free from any trace of the acid. To protect the raw surface, the wound is covered with so-called "protective." This is simply a piece of thick green oiled silk brushed over with one part of dextrine to two of powdered starch in 16 of cold water solution of carbolic acid, and allowed to dry. Before being applied, it is dipped in a solution of carbolic acid (1 to 40). It is in itself perfectly unirritating, and is almost impervious to carbolic acid, so that, as soon as the small quantity of the acid adhering to its under surface has been absorbed by the skin or granulations beneath, the wound is almost absolutely excluded from any direct action of the irritating antiseptic. The protective should extend about one inch on each side of the wound, and over this should be placed a single layer of the "antiseptic gauze," which has been dipped in the 1 to 40 solution, and squeezed as dry as possible. If much discharge is to be expected, two or three layers of wet gauze may be employed. Over this, and extending at least six inches on every side of the wound, is placed a dressing of dry antiseptic gauze, folded eight layers thick. If it be impossible to make it extend far enough round the wound, the number of layers must be increased. Between the two most superficial layers is placed a piece of thin Mackintosh cloth, so that the discharge may not soak through at one spot and decompose, but may be evenly diffused over the whole dressing. The cloth should be dipped in

the 1 to 40 solution before being used. Over all is laced a bandage composed of antiseptic gauze, secured at several points by pins. Care must be taken not to puncture the Mackintosh cloth with the pins. The spray must not cease for a moment till the wound is securely covered with the dressing, and care must be taken to direct the spray actually on the wound, and not, as may happen, merely on the back of the gauze as it is being applied. In changing the dressing, the same rules must be observed, and the wound never for an instant exposed to view except under a spray of carbolic acid and water. While preparing the new dressings, to save the trouble of working the spray, the wound should be covered with a "guard," as above described. The same piece of Mackintosh cloth may be used all through the case, if it be washed at every dressing in carbolic acid and water. It should be examined every time to see that the waterproof layer has not peeled off, and that it is free from pin-holes. The dressing must be repeated at first every day, till the serous discharge has ceased, and then every second, third, or fourth day, according to the amount of discharge. If it be thought necessary to apply strapping to the wound, it may be done under the spray, by dipping the plaster in a one part of carbolic acid and water (1 to 20), to which is added an equal quantity of boiling water. Although attention to detail is of great importance, and in description the dressing may seem complicated and tedious, its application to a wound such as that of an amputation, does not take more than five minutes; and as all washing, syringing, and examining ligatures, &c., are saved, it is not more troublesome than the ordinary mode of treatment.

Although the above described plan is always to be followed when the necessary materials and appliances are at hand, it must not be supposed that in their absence antiseptic treatment is impossible. It may be conducted as follows. The bleeding having been arrested by torsion, and the wound syringed out as above described, and the sutures put in, the nozzle of the syringe is to be introduced between the sutures, and the wound carefully washed out once more through the drainage tubes and immediately covered with a "guard." A large piece of lint soaked in carbolic acid and olive-oil (1 to 10) is then applied, extending some distance beyond the wound in every direction. The guard may then be withdrawn from beneath the lint without again exposing the wound. This dressing requires changing more frequently than the gauze, and is not so certain in its action. In dressing the wound, a stream of carbolic acid (1 to 40) may be run over it from a sponge, when it is unavoidably exposed without a guard. If no drainage-tube be at hand, its place may be taken by a slip of lint soaked in the carbolised oil. A well made pad of carded oakum is in every way as efficient as the antiseptic gauze, as far as its power of preventing decomposition is concerned It should be covered with oiled silk or gutta-percha tissue to prevent the discharge from soaking through at one spot. The chief objections to the oakum are, the difficulty of making a uniform smooth pad from it, and the blackening and occasional irritation of the skin from the tar. The irritation is best prevented by smearing the skin with olive oil and carbolic acid (1 to 10).

During the last few years **salicylic acid** (a derivative of carbolic acid) has been used extensively in Germany, especially by Thiersch, as a substitute for carbolic acid. Its antiseptic powers are stated to be greater, it is free from odor, has a faint sweetish taste, and is not volatile. Thiersch uses it as a spray in the proportion of 1 to 300, and states that its action is equal to the carbolic spray. If so, as the acid is not vola-

tile, the spray can only act by sweeping the air and collecting the dust on the particles of the fluid, and by covering the wound with a thin layer of the acid solution. In sloughy wounds the acid is powdered over the surface, either pure or mixed with starch. In dressing fresh wounds, Thiersch uses cotton-wool moistened with a concentrated solution of the acid and afterwards dried, or a dressing constantly irrigated with the solution (1 to 300). Those who believe in the power of the vapor of carbolic acid to prevent decomposition, consider the non-volatility of salicylic acid a great drawback to its use. Experience has shown that it is not less irritating; so that, except in cases in which the smell is unbearable to the patient, it presents few, if any, real advantages over carbolic acid.

For dressing superficial wounds, Lister has for some years past made use of **boracic acid**. The antiseptic powers of this acid are not equal either to carbolic or salicylic acids, but it is proportionately less irritating when in direct contact with the skin or an ulcer. In using it, the raw surface should be washed with a saturated solution of the acid and covered with a piece of "protective," previously dipped in the same solution. Over this are placed two or three layers of wet boracic lint, which are secured with a common bandage and left to dry. The boracic lint is prepared by dipping common lint in a saturated boiling solution of the acid and allowing it to dry. It will then be found to be impregnated with the peculiar soft crystals of boracic acid. If decomposition be present on the surface of the wound or ulcer, the sore should be first washed with a strong solution of chloride of zinc or of carbolic acid, the boracic solution not being sufficiently powerful for the purpose. As boracic acid is to be used only when the wound has become a superficial sore, the use of the spray is unnecessary. Another valuable preparation is the boracic acid ointment, composed of one part of boracic acid to one of white wax, two of paraffin, and two of almond oil. It requires to be warmed and then spread upon a piece of fine linen rag. It has no tendency to adhere to the surface of the sore, and allows the discharge to ooze out from beneath it at the edges of the dressing, at the same time preventing its decomposition. The preparations of boracic acid are especially useful when the operation of skin-grafting is employed. Each little graft may be dipped in the solution of boracic acid without any fear of destroying its vitality, and the freedom from decomposition ensured by the dressing greatly increases the certanity of the operation.

But it is not only by the employment of antiseptics that the decomposition of the secretions in a wound may be prevented. Means for **securing the free exit of the secretions** are almost equally serviceable.

The decomposition of the fluids in wounds—of the effused blood and liquor sanguinis, and of that sanies which is always poured out more or less abundantly from cut surfaces, may be prevented by affording it facilities of escape, or by washing it away as rapidly as it forms. It is in this way that septic contamination of wounds is often prevented, although no antiseptics are used. On this principle is conducted the "open air treatment" of wounds, strongly recommended and successfully practised by Humphry, in which, though air is freely admitted, the ill effects of pent-up decomposing secretions are obviated. The treatment of wounds by constant irrigation, or by the tepid bath, is often very successful for the same reason. The older Surgeons secured free discharges by open dressings, with stimulating balsams, tinctures, and ointments, which, however, were partly antiseptic; or by the use of tents and plugs introduced into the angles and depending parts of wounds,

whence they were periodically removed, in order to give it exit to the retained discharges.

A favorite method of dressing wounds in the pre-anæsthetic period consisted in leaving the cavity open and freely exposed to the air until all oozing of blood had ceased and the surfaces were "glazed," *i. e.*, covered with a layer of fibrine. They were then brought together, the discharges draining away along the ligature threads, which were brought out at the lowest part and the edges covered with water-dressing. In this way ready union, with little if any suppuration, was often secured; and I have witnessed and obtained as good results by this as by any other plan of treatment.

With the introduction of anæsthetics this practice was changed, and in order to save the pain of a second dressing, the wound, if a surgical one, as in an amputation, was "put up" at once before the patient was removed from the operating table—before all oozing had ceased, and before the process of "glazing" had commenced. This practice led to most pernicious results, for no provision having been made for the escape of sanies, this, often mixed with blood-clot, the result of oozing, became retained in the wound; these decomposed, and thus became the fertile source of profuse suppuration, sloughing, putrescence, and pyæmia. The introduction of the drainage-tube by Chassaignac into surgical practice, and its adoption by many Surgeons in this country, as an adjunct to the ordinary dressings of operation-wounds, led to great improvements in the results of operations; for by affording a ready exit and aperture of discharge for the sanies, which would otherwise have been pent up, its decomposition was prevented, and all the consequent evils averted.

The drainage-tube is, as has been seen, an essential part of the "antiseptic method;" and its use should never be omitted, whether that treatment be adopted or not, for by it alone can the manifold evils of decomposing pent-up secretions be prevented.

That the "Antiseptic Treatment" has been of much service in the prevention of the infection of wounds, more especially in old, crowded, and pestilential hospitals, there can be little doubt. We have, however, unfortunately as yet no definite data by which to judge of the comparative merits of this and other modern methods of treating wounds. The general recognition by Surgeons of the necessity of the free drainage of wounds, with or without the employment of antiseptics, has undoubtedly tended, more than any one single improvement in practice, to lessen those evils which necessarily result from the decomposition of pent-up fluids in contact with raw surfaces. So also the general employment of disinfectants of all kinds, and the great attention that is now bestowed on hospital hygiene in the recognition of the importance of abundant air-supply and free ventilation, of the evils of over-crowding, of the necessity of care in the distribution of patients, and in the avoidance of all carriers of infection, such as sponges, instruments, clothes, &c., have greatly tended to improve the sanitary condition of most hospitals —and to lessen the liability to the generation and diffusion of septic disease. The introduction of the "antiseptic treatment" being contemporaneous with the general adoption of improved hospital hygiene, the patients subjected to this method necessarily participate in the advantages that flow from exposure to sanitary conditions that have been so much altered for the better. Hence it is not reasonable or just to ascribe a diminution of the amount of septic disease in a hospital in which the "Antiseptic Method" is employed, to that alone, and to the exclusion of all other causes. Either hygiene is of no value in surgical cases, or some

and probably no inconsiderable share in the improved results must in justice be assigned to the generally ameliorated sanitary conditions. The only comparison that can justly or scientifically be instituted, is between one set of patients treated antiseptically with another of a similar kind subjected contemporaneously to other methods of treatment. And for this comparison to have any practical value, it must be continued for a sufficiently lengthened period to eliminate all sources of error from accidental causes. It is manifestly unscientific to compare the results of modern with those of older methods of surgical practice, even in the same institutions, where the attendant conditions, independent of mere treatment, are dissimilar; and it is equally incorrect and unjust to refer all improvements in results to one only of the many improved conditions to which the patient is now subjected.

Inflammation of Incised Wounds.—If union by the first intention fail from any local or constitutional cause, inflammation takes place in and around the wound; the lips swell and become red; a sero-sanguinolent discharge, gradually assuming a puriform character, exudes; and at the same time a general febrile state sets in, attended with rise of the pulse and temperature, heat of skin, thirst, etc., which continues until suppuration is fairly established. The thermometer will always give timely warning of the approach of this "primary traumatic fever" by indicating a rise of 2° or 3° Fahr. The use of this instrument in surgical practice is attended with great advantage, as it is often the first to indicate the onset of some of the more serious sequelæ of wounds and injuries. In these circumstances, the sutures should be immediately removed; the strips of plaster, if their use be continued, should be used for support only, and not for union; a thick piece of warm-water dressing should be applied, and the general condition of the patient appropriately treated. When granulations have sprung up, and suppuration has fairly set in, the treatment must be conducted in accordance with those general principles that guide us in the management of ulcerated surfaces (pp. 185 *et seq.*). The suppuration must be moderated, the process of cicatrisation facilitated by the application of a bandage, the general health attended to, and the strength of the patient supported. With the view of stimulating the granulations to cicatrise, and to check the formation of pus, the carbolized water dressing may be replaced by lotions of sulphate of zinc (two grains to the ounce), sulphocarbolate of zinc (three or four grains to the ounce), lime-water, etc. If any tendency to ulceration or formation of sloughs be met with, a wash of nitric acid and opium (extracti opii gr. v., acidi nitrici dil. m. x. to the ounce), or lotions of iodine, sulphite of potash, or chloride of zinc, of requisite strength; in the latter case, the deeper parts of the wound should be well syringed out with the lotion. When the granulations are high, pale, and flabby, they should be rubbed down with sulphate of copper, or touched freely with solid nitrate of silver.

An intercurrent attack of traumatic inflammation will at once put a stop to the process of union; the parts around become swollen, hot, and painful, the formation of pus ceases, the wound is dry and angry-looking, and portions of it already healed open up once more. Hot fomentations or warm emollient poultices should be applied until suppuration is re-established, when they may be replaced by cooling lotions and cold compresses; when all signs of inflammation have passed, the granulating surfaces may be again brought together by sutures, plasters, and bandages, with a view of their uniting by "secondary adhesion." On the other hand, should the inflammation run on to gangrene, the separation

of the sloughs must be accelerated by poultices, whilst the powers of the patient are sustained by liberal diet, with the free administration of stimulants. Putrefaction and fœtor must be combated by the use of lotions containing carbolic acid or some other antiseptic.

In very severe cases of traumatic inflammation, especially in wounds implicating the joints, compression or ligature of the main trunk leading to the seat of injury has been practised, with the object of limiting the quantity of blood in the tissues, and regulating the circulation through them, so that the processes of repair can be more rapidly entered on. For further remarks on this subject, the reader is referred to page 151.

Faulty Cicatrices may give rise to much disfigurement from excessive or irregular contraction; and various plastic operations, which will be described more fully hereafter, are recorded to remedy this inconvenience. Much benefit will occasionally result from excising the cicatrix, and then bringing together the opposite edges of the wound in an uniform smooth line. Should it be too large for this, if flat, it must be less; if angular, as the flexure of a joint, it may be divided down to the sound structures beneath, and the gap thus left filled by a flap of integument dissected from the neighboring parts and twisted into it. Again, in certain situations on the trunk, cicatrices will yield before the pressure of the viscera and thus give rise to herniæ. In some cases they remain weak, thin, and tender for a considerable period, with constant tendency to break down; these conditions of cicatrices are generally due to constitutional causes. They may also become painful, or be the seat of pigmentary deposits. In other rare instances they undergo a species of hypertrophy of a non-malignant character, chiefly met with after burns, which is called *spurious* or *Alibert's keloid*, to distinguish it from true keloid, that does not attack scars. This condition may call for surgical interference, but it often disappears spontaneously.

CONTUSED AND LACERATED WOUNDS.

These may be defined to be wounds that are attended by more or less bruising about the edges and sides; presenting every possible variety in the degree of contusion and of wound, from a cut on the shin to the crushing and laceration of a limb by a cannon-shot. They are commonly inflicted by blunt-cutting instruments, as by a hatchet, or by stones, bludgeons, etc. Lacerations by machinery, in which parts are torn off or crushed, the bites and gorings of animals, and gun-shot injuries of all kinds, come under this denomination.

Characters.—Whatever their mode of infliction, these wounds present certain characters in common, by which they differ from all other injuries. Their lips are irregular and torn, less gaping than incised wounds, but surrounded by more or less ecchymosis and contusion, with a tendency to slough at their sides. There is usually but little hæmorrhage, and the pain is of an aching or dull character. In consequence of the sloughy state of the lips and sides, these wounds almost always unite by the second intention.

Contused and lacerated wounds present peculiarities according to the mode of their infliction.

When they are occasioned by the bite of a large animal, the part injured becomes very painful, and inflames extensively; the wound being lacerated, much contused, and often penetrating deeply. It sloughs in consequence of the pressure to which it has been subjected, and of the shaking and tearing of the part by the animal. When inflicted by the

tusk or horn of an animal, the wound is extensively lacerated rather than contused, and often partakes of the nature of a punctured wound.

When a part of the body is torn off, the wound presents peculiar characters; which differ, however, according as the separation is effected at the part struck or seized, or at a distance from it.

In the first case—as when a cannon-ball carries off a limb, or an arm is caught in a steam-mill or rag-tearing machine and crushed or torn off—the stump presents a very ragged surface, the skin being stripped away higher than the other parts, the tendons hanging out, and the bellies of the muscles that are torn across being swollen, protruding, and apparently constricted by the lacerated integument. A most important condition in such wounds is the state of the vessels; these are separated lower down than the other parts, for, being elastic, they elongate and pull out before they give way. There is no hæmorrhage, because the inner and middle coats of the artery, breaking off short, retract and contract to a small aperture, and allow the external coat to be dragged down and twisted over its mouth, in such a way as to offer a complete barrier to the escape of blood. The bone is crushed off at the end of the stump, of which it forms the irregular conical apex, and is often split up to the next joint above.

Occasionally, when parts are pulled off, they are separated at a distance from the point seized. Thus, fingers that have been torn off by machinery have their extensor tendons separated higher up, at their junction with the belly of the muscle, and not at the part seized; the tendon being drawn out of its sheath, and hanging on to the separated end in a ribbon-like manner. In railway accidents, when a train has passed over a limb without completely separating it, the muscles may be found detached from their origins.

Progress.—In the progress of a contused or lacerated wound there are two distinct periods: 1, that of the Separation of the Slough produced by the contusion; 2, that of Repair by Granulations of the chasm left. These processes are analogous to those which occur in ulceration, and are described at pages 181 and 182.

The **Extent of the Slough** depends not only upon the extent and severity, but also upon the situation of the injury. If the parts around the wound be much bruised, then superficial sloughing to a great extent may occur; if the wound be deep though not extensive, there will always be danger of troublesome sloughing, leading to deep suppuration and burrowing of matter, and in some cases to secondary hæmorrhage. Those wounds that are situated immediately over bony points—as the shin and elbow—are especially tedious, as the slough frequently implicates the fasciæ. The scalp has a less tendency to slough than any other part of the cutaneous surface. This is owing to its great vascularity, and to the large supply of blood which it receives from closely subjacent arteries. In all cases of contused and lacerated wounds—more especially in those of the scalp—there is great danger of the supervention of erysipelas.

But the chief danger to be apprehended in wounds of this description is the supervention of **Traumatic Gangrene**, which may occur in three ways.

1. The contusion always kills a thin layer of tissue, which forms a slough on the sides or lips of the wound; but in some cases the violence done to the part is so great as directly to kill its whole substance. Thus, if a limb be crushed to a pulp by machinery, or by the passage of a heavy wagon over it, all circulation is completely and at once arrested,

the vitality of the part is destroyed outright, and it will speedily fall into a state of putrefactive decomposition, with all the usual signs of advanced mortification. If the violence be not quite so great as this, the vitality of the part may be lessened and its resisting power diminished to such an extent, that the inflammation necessary for the repair of the injury terminates in gangrene. This is a local traumatic mortification, evincing no disposition to spread beyond the part injured, but being bounded by a line of demarcation along which it will separate. It is not always easy to distinguish this direct form of gangrene from such discoloration and disorganisation of a limb as are still compatible with life. In all cases of doubt the Surgeon must wait, and a very short time—a few hours—will be sufficient to declare whether the vitality of the part can be maintained or not. In cases of much doubt an incision might be made into the part, and the true state of things thus ascertained; but this should not be done if it can possibly be avoided.

2. The injury may be chiefly inflicted upon the great vessels of the limb, damaging them to such an extent as to interrupt completely the circulation; gangrene being thus induced indirectly in the parts supplied by them. This form of gangrene we shall have occasion to treat of fully when speaking of Injuries of the Arteries.

3. The true traumatic or "spreading gangrene," the most fatal variety of mortification, is most commonly the result of severe contused and lacerated wounds, particularly when complicated with fractures It has a tendency to spread rapidly, especially through the areolar planes of the limb, often involving the whole member in less than twelve hours after its invasion.

The true **Spreading Traumatic Gangrene** is invariably of the dark and humid kind. In it, death of the tissues and their putrefaction are contemporaneous. The putrefactive process does not take place in this, as in the other varieties of gangrene just described, some hours, or days even, after the cessation of vitality in the part; but the purplish-black color, the fœtid odor, and the development of gas, occur at the moment of the death of the tissues, and are evidently dependent on some peculiar septic condition of the parts attacked by the disease. It differs from the other varieties of gangrene in having no disposition to limit itself by a line of demarcation, as well as in the rapidity of its extension and the speedy putrescence that occurs in the part attacked.

The *Causes* of this form of traumatic gangrene are local and constitutional combined. The *Local Causes* consist of injuries, more particularly contused and lacerated wounds of the hand or foot. As a general rule it may, perhaps, be stated that the more severe forms of injury of this description, more especially such as implicate joints or bones, are more liable to be followed by this form of gangrene; but it would be an error to suppose that severe injury is a necessary precursor of it. Comparatively slight injuries, provided they be of the nature of lacerated wounds, have not unfrequently been the occasioning cause of traumatic gangrene of the worst form. Another way in which traumatic gangrene is produced is by the engorgement of the tissues, and consequent strangulation by effusion of serous fluid into the intermuscular planes of the areolar tissue.

The *Constitutional Condition* of the patient is undoubtedly the main cause of the supervention of spreading traumatic gangrene. However severe an injury may be, and however certainly it may kill those tissues or those parts of limbs which are directly and immediately exposed to the operation of the external violence, the rapidly spreading form of the

disease will not supervene unless the constitution be in an unsound state; and this remark applies necessarily with especial force to its occurrence after the slighter forms of injury. The supervention of spreading traumatic gangrene will occur in circumstances similar to those which dispose to pyæmia, erysipelas, or sloughing phagedæna; and, in fact, to the low and diffuse inflammations generally. They consist of imperfect and faulty hygienic conditions, and an impure state of the blood, arising either from long-continued exposure, antecedent to the injury, to such conditions, or from chronic disease of the eliminatory organs, more particularly of the kidneys. Defective depuration of the blood, consequent on chronic kidney-disease, is a most fertile cause of this as of the other forms of gangrene. Indeed, I believe that the true spreading traumatic gangrene cannot occur unless the blood be, *previously* to the receipt of the injury, in a depraved and disordered state, the result of the conditions, singly or combined, above mentioned. Hospital miasmata, and exposure to faulty hygienic conditions after the receipt of the injury, do not appear to me to exercise so marked an influence on the occurrence of this form of gangrene as of the low inflammatory diseases of the erysipelatous type. In fact, the patient is rarely, if ever, exposed to these influences sufficiently long after the occurrence of the injury for them to have much effect on his constitutional condition, had that been in a sound state previously. Spreading traumatic gangrene occurs only in recent wounds, and usually manifests itself within the first three days after its occurrence, whilst they are still in their first stage, and before suppuration has set in. When once this has occurred, and especially if the wound be granulating, the patient may get erysipelas, or pyæmia, or sloughing phagedæna; but he will no longer be susceptible of the spreading form of traumatic gangrene. I cannot, therefore, but look upon this formidable disease as a truly constitutional affection, depending more upon the state of the patient's blood at the time of the reception of the injury, than upon the severity of that injury, or upon the circumstances to which he has been exposed immediately after the receipt of it.

The *Symptoms* are as follow. The wounded limb at the seat of injury swells, becomes dusky, red, and has a deep-seated, tensive, burning pain. The swelling, redness, and tension spread upwards, and are speedily followed by a dusky purplish tint, by a soft doughy feeling of the parts, and in the course of a few more hours by a deep blackish-purple discoloration, which spreads uniformly and with great rapidity through all the tissues affected. This is accompanied or immediately followed by emphysematous crackling, due to the presence of gases which are developed by the decomposition of the parts attacked by the gangrene. The changes, which are of a putrefactive nature, first develop themselves in the wound itself, and speedily extend from it to the surrounding parts. That portion of the limb which is below the gangrened part becomes pale, cold, and œdematous. The portion which is above becomes rapidly infiltrated by serous exudation, which runs up the inner side of the limb to the axilla or groin, as the case may be. The part immediately above the limit of the tissues that are actually mortified is greatly swollen by œdematous infiltration, tense and pitting slightly on pressure, usually mottled in color of shades of greenish or greyish yellow, like a bruise that is passing off. This œdema and peculiar discoloration extend higher along the inner side of the limb, where it always first reaches the trunk. Emphysematous crackling rapidly spreads itself along the same parts, and the gangrene here travels with great rapidity,

hopelessly involving the tissues and entering into the areolar planes of the axilla or groin in a very few hours. As the gangrene advances, the parts affected fall into a soft, pulpy, black mass.

On making an incision into the parts so affected, it will be found that the gangrenous disorganisation is primarily seated in the areolar planes of the limb, and that the muscles are not affected in the first instance. It will also be observed that the disease extends itself through the areolar tissue, the skin falling secondarily into slough.

The constitutional symptoms are throughout of the lowest ataxic type; and death almost invariably ensues in three or four days after the invasion of the disease, and always very shortly after the gangrene has reached the trunk.

Treatment of Contused and Lacerated Wounds.—In the treatment of the slighter form of these injuries, we must bear in mind the occurrence of the two distinct periods: 1, that of sloughing; and 2, that of granulation. There is also in all injuries of this description a special tendency to the occurrence of erysipelas and allied diseases.

Care must be taken to clean the parts thoroughly from foreign bodies that are frequently impacted or ground into them. However contused and torn a flap of skin may be, it should, as a general rule, never be separated, provided it maintain any attachment to the neighboring tissues, but should always be replaced on the chance of its vitality being preserved. If it live, as it will often do, especially about the scalp, under apparently the most discouraging circumstances, much will be gained; if it slough, no harm can result from the attempt to preserve it. There are even cases on record in which parts that have been completely separated have become attached, by being immediately reapplied to the surface from which they had been torn. Whether this be actually the case or not, it is at all events certain that a very small tongue of skin is sufficient to maintain the vitality of a part. This we see exemplified in the operation for the restoration of a lost nose; and cases have occurred to me in which the nose, nearly cut off, being only retained by a portion of one ala, has readily united on being replaced; so likewise, in bad cases of compound dislocation of the fingers, the part has been saved, though merely attached by a narrow bridge of skin. After a part has been replaced in this way, it should be retained *in situ* by a few points of interrupted suture, with a piece of lint soaked in collodion applied to the line of wound. The sutures must be left in for a somewhat longer time than usual, until good union has resulted. The hæmorrhage, as before mentioned, is as a rule easily controlled; position, application of cold, and the subsequent bandaging being sufficient in the majority of cases. When, however, the blood is bright-colored and continues to drip from the wound, a vessel of some size has been divided: this should be searched for, and the opening closed by torsion or ligature.

In ordinary cases of contused or lacerated wounds, whether superficially extensive or deep, we must facilitate the separation of the sloughs by the application of warmth and moisture, which also serve to subdue local inflammation. Carded oakum, moistened in hot water and covered with oiled silk, answers this purpose better than poultices: it is cleaner and more readily applied, soaks up the discharges, and is to a certain extent antiseptic.

Disinfectants should be freely used in all contused and lacerated wounds. The wounds must be washed, syringed, or sprayed out several times a day with weak solutions of the chlorides, of the permanganates, or of carbolic acid. In this way sloughs and decomposing pus may be

removed, and the tendency to local inflammation of an erysipelatous character, and the development of pyæmia, averted. There is no more fertile cause of these disastrous effects than the retention of fœtid decomposing pus in the areolar tissue of a contused wound. It is in this class of wounds that the antiseptic treatment has met with its greatest success. Under its use, union has taken place in very extensive injuries, loss of substance being replaced by granulations; the crushed and torn tissues, which would otherwise have probably sloughed off, appearing to become revitalised: and all this has occurred without any general febrile disturbance, and with the loss of but a small quantity of serous fluid in the shape of discharge. But, valuable as the antiseptic treatment incontestably is in many of these cases, it may occasionally fail in preventing suppuration. Should this happen, all plasters and tight and obstructive dressings must at once be removed, so as to allow a free exit of the discharges from the wound. If this precaution be neglected, the most disastrous consequences, local and constitutional, will ensue from the retention and infiltration of the pus and decomposing material in the texture of the limb or part.

About the period at which the slough begins to be loosened, there is danger of the occurrence of **hæmorrhage**, if a large artery have been implicated in the injury. When hæmorrhage occurs in this way, it usually sets in from the sixth to the twelfth day, and may be speedily fatal; its treatment will be the same as that to be hereafter described for secondary hæmorrhage after ligature of an artery in its continuity. After the sloughs have separated, an ulcer is left, which must be treated on general principles.

Amputation.—In the more severe cases of contused or lacerated wounds, any attempt at saving the part may be hopeless, and the patient's only chance lies in *amputation.* In determining the expediency of operation, two questions present themselves; 1, the nature of the cases in which amputation should be performed; and, 2, the time at which it should be done, whether immediately after the infliction of the injury, or subsequently.

It is difficult to lay down more than very general rules as to the *kind of cases that require amputation;* much depending on the age, constitution, and previous habits of the patient. In all cases the Surgeon should be careful not to condemn a limb that admits of a fair chance of being saved; and, if the patient should happen to die, as he often may, from the after-effects, such as erysipelas or phlebitis, of a contused wound that admitted a fair prospect of recovery, the Surgeon may justly console himself with the reflection that, with the constitutional disposition leading to these diseases, the injury inflicted by the amputation would in all probability have been equally fatal, and that thus the patient has been saved the pain of an operation that would have been unsuccessful in its result.

As a general rule, severe injuries are more readily recovered from in the young than in the old, their vitality and elasticity of constitution being greater, with less tendency to consecutive diseases. Much will depend upon the habits of the patient, or upon the existence of visceral disease at the time of the injury. In persons who have been free livers, and who have that peculiar irritability of system conjoined with deficient power commonly observed in such subjects, and more especially if there be already existing disease of the liver or kidneys, contused and lacerated wounds are apt to be followed by the worst forms of erysipelas and traumatic gangrene, and thus to be speedily fatal. Injuries of the upper

extremity are less serious than those of the lower; its supply of blood being proportionately greater and more uniformly distributed. In some badly contused wounds, also, of the arm and hand, as in bad lacerations with fracture about the shoulder, elbow, or metacarpus, resection of the injured part may be performed instead of amputation of the limb.

Though there may always be this doubt as to the cases that should not be amputated, there are certain conditions in which the Surgeon need never hesitate to perform this operation, as the only chance of saving the patient's life. The following are the cases of severe contusion and laceration in which the limb should be amputated; either with the view of preventing the occurrence of gangrene, or in order to remove a mortified part from the body, and thus to save the life of the patient at the expense of the injured limb.

1. If a limb have been torn off by machinery, carried away by a cannon-ball, or cut off by the passage of a railway-train over it, the irregular and conical stump should be amputated, so as to leave a more useful and healthy one to the patient.

2. If the whole thickness of a limb—the soft parts and the bones—be thoroughly disorganised and crushed, it must be removed.

3. If the soft parts be extensively stripped away from the bones, though these be entire, so much sloughing and suppuration will ensue as to leave a useless limb, and amputation should be performed. It is in these cases that it is often especially difficult to estimate the amount of injury that cannot be recovered from, this depending much upon the age and constitution of the sufferer. I believe that Surgeons, in their anxiety to save a limb, often lose a patient under these circumstances. I have more than once had reason to regret having attempted to save limbs injured in this way; and believe that, if the skin of the lower extremity be extensively torn down and the muscles much lacerated, so as to slough away, there is but little chance for the patient—unless he be very young, and of a remarkably sound constitution—except in amputation. In the upper extremity it is different; there, recovery may take place under the most adverse circumstances.

4. So also, if the knee be largely opened, with laceration of the soft parts and perhaps fracture of the contiguous bones, the limb must be amputated. Corresponding injuries of the ankle, shoulder, and elbow joints, may, as has already been stated, admit of resection rather than of amputation.

5. Bad crushes of the foot have a great tendency to run into gangrene, and hence require amputation. In the hand, on the contrary, very extensive injuries are often recovered from, without this operation being necessary; and in many cases partial resection may be substituted for it.

6. In those cases in which a large artery, as the femoral, is lacerated at the same time that the soft parts are extensively injured, and the bone fractured, amputation is required in order to prevent the occurrence of gangrene. In the more local form of traumatic gangrene, in which the disease is confined to the part directly crushed and injured, no good can come of delay, and amputation should be performed as soon as mortification has declared itself; and the limb must be removed at a sufficient distance from the seat of mischief. Thus, if gangrene of the foot or ankle come on in consequence of a smash of these parts, the upper part of the leg or the thigh in its lower part should be amputated. When the mortification results indirectly from injury of the vessels, the limb should also be immediately removed in a line with the wound, unless this be too high up; then the most favorable point must be seized, as

will hereafter be explained. Amputation in these circumstances is by no means a very unfavorable operation (and it is one that I have several times successfully performed), provided it be done sufficiently early, before the constitution becomes poisoned by the absorption of morbid matters from the gangrenous limb. It is scarcely necessary to warn the Surgeon to be certain of the existence of gangrene before he operates; and also that it be not a mere limited slough, but sufficiently extensive to jeopardise the patient's life.

7. In those cases in which the true traumatic or rapidly spreading variety of gangrene is wholly or in part due to strangulation of the tissues by serous extravasation into the areolar planes, much benefit may be anticipated, and the further progress of the malady stayed, by early and free incisions carried through the engorged structures (*débridement*); an outlet is thus afforded to the effused fluids and to those portions of areolar tissue already in a state of slough. But in all others, and these unfortunately are by far the most numerous, in which the *true traumatic* or *rapidly spreading gangrene* has set in, the Surgeon will be placed in a great difficulty, whichever way he act. If he trust to constitutional treatment, in the hope of a line of demarcation forming, he will almost certainly be disappointed, the gangrene rapidly spreading up to the trunk; and if he amputate, he may probably lose his patient by the stump becoming affected. Yet amputation should, in my opinion, be performed at once. For, although this operation is necessarily very unfavorable when practised in these cases, in consequence of the gangrene not being a local affection, but dependent on constitutional causes, yet it must be remembered that, if the Surgeon wait for the line of demarcation or trust to other means, such as incisions or general treatment, the patient will almost to a certainty die. The patient's safety in these cases, then, lies in amputating early, and removing the limb high above the part affected; thus, in spreading gangrene of the arm, at the shoulder-joint; and of the leg, in the upper part of the thigh. The necessity for high amputation in these cases is owing to the gangrene spreading more extensively in the areolar tissue than it does in the skin; and hence in reality invading the limb to a higher point than it appears externally to do. In most cases it will be found that the infiltration precursory to the gangrenous mischief runs up one side of the limb—the inner or posterior—to a much greater extent than the other. In amputating under such circumstances, the Surgeon may often very advantageously so fashion his flaps as to exclude as much as possible of the affected part or side of the limb, forming them chiefly from that least affected. A principal source of danger and of death, after amputation in these cases, is the great disposition to the recurrence of the morbid condition in the stump, more particularly in the lower extremity. Out of twelve cases in which I have seen or done amputation for this disease, this recurrence happened in seven instances. This tendency will be increased by the proximity of the line of amputation to the gangrenous limit. But, even under the most unfavorable circumstances, recovery will sometimes take place. Thus I have seen the flaps in amputation for spreading gangrene infiltrated with gelatinous-looking fluid, and yet recovery take place. In a man whose arm I amputated at the shoulder-joint for spreading gangrene of the limb, the infiltration had extended as high as the scapula; yet he made a very excellent recovery. In the lower extremity the liability to recurrence of the gangrene is, however, very much greater; and there can be but very little prospect of saving the patient if the thigh have once become reddened and infiltrated, even

though the gangrene do not extend above the knee—invasion of the stump ensuing under such circumstances with almost absolute certainty.

Much of the success of the case will depend on the after-treatment. This must consist principally of light dressings to the stump, full doses of liquor opii, and the early and free administration of stimulants, more particularly brandy and wine; and attention to these points will often bring the patient through, though usually not without much difficulty and great constitutional disturbance.

The question as to the *period* at which amputation should be performed in contused wounds, has already been considered at pp. 81 to 83. It may be generally stated, that the sooner a condemned limb is taken off, the less is the suffering, and the better the chance of recovery to the patient; and that, consequently, primary amputation should be practised in these cases. By reference to the table on p. 82, it will be seen that, although the average mortality for all primary operations is less than the average mortality for all secondary operations, yet primary amputation through the thigh is more fatal than secondary amputation in the same region. Notwithstanding this, it is absolutely necessary in many cases to remove the injured limb within the first twenty-four hours. The higher rate of mortality of primary thigh amputations may be chiefly due to the greater severity of the injuries that manifestly require immediate operation, than of those in which it is thought justifiable to attempt to save a limb; and certainly, of the two alternatives, of leaving a badly crushed and mangled limb until suppuration has set up, and thus exposing the patient to all the risks of gangrene, erysipelas, pyæmia, &c., or removing it at once, the latter is the one attended with least danger to the patient.

A limb is sometimes so severely and hopelessly crushed and torn that any attempt at its preservation must be useless; whilst at the same time the patient is so severely injured internally, or is so prostrated by the general shock to the system, that amputation as a formal operation would be as useless as it would be unjustifiable, the patient having at most, perhaps, but a few hours to live. In these circumstances the best thing that can be done is to put on a tourniquet tightly, partly to restrain hæmorrhage, and partly to restrain the painful quivering of the muscles, and to wrap up the maimed limb in a wet cloth. Should the limb have been nearly completely detached—merely hanging on by shreds of the lacerated muscles—these may be divided, and its removal thus effected without additional shock or suffering.

Brush-Burn.—There is a peculiar species of wound, that partakes perhaps more of the characters of those wounds that we have just been considering than of any other, and is occasioned by rapid and severe friction of the surface of the body, so that the skin becomes abraded and the subjacent tissues somewhat contused. It goes by the name of a "brush-burn," and is not unfrequently produced in the manufacturing districts, by the surface of the body coming into contact with straps or portions of machinery in rapid revolution. It has also been known to occur in consequence of a person slipping and sliding rapidly down a long and steep Alpine snow-slope. In this injury the integumental structures are, as it were, ground off, and the areolar and aponeurotic structures converted into an eschar.

The *Treatment* presents nothing special, but may be conducted on ordinary principles. The separation of the eschars must be facilitated by water-dressing and poultices; the resulting sores will heal by granu-

lation; and the general health must be supported during the suppurative period that must necessarily ensue.

PUNCTURED WOUNDS.

These wounds, made by narrow sharp-pointed instruments, vary greatly in extent, from the prick of a needle in the finger to a sword-thrust through the body. Not unfrequently punctured wounds are somewhat contused, being made by a triangular or wedge-like weapon, as a bayonet or lance-blade. Hence they partake of the general character of contused wounds, having a tendency to unite by granulation from the bottom, and to be accompanied by much inflammatory action. When deep, they are of a most dangerous character—wounding blood-vessels, traversing the great cavities, and injuring the contained viscera.

TREATMENT.—In the treatment of punctured wounds, the principal points are to arrest the hæmorrhage, and to facilitate union.

The hæmorrhage must be arrested by pressure properly applied by means of compresses or pads, so as to approximate the sides of the puncture; by the application of cold; or by cutting down on the injured vessel if it be a large one, and ligaturing it above and below the perforation in it.

In the majority of cases, unless the injury be a slight one, suppuration and union by the second intention will take place. But in many instances union by adhesion is obtained; and in those that are allowed to suppurate, there can be little doubt that the same favorable termination might be secured if proper attention were paid to the injury. The cavity should be injected with carbolic acid lotion; all superfluous moisture should then be carefully expressed; the external opening closed by collodion or styptic colloid, or after Lister's method; and the sides kept in contact by compresses and bandages. Undue inflammation must be kept down by cooling lotions, &c. In former days, when duels with the small sword were of frequent occurrence, persons called "suckers," who were often the drummers of a regiment, were employed to attend the wounded combatants. Their treatment, which was conducted with a certain degree of mystery, consisted in sucking the wound till all blood ceased to flow, and then applying a pellet of chewed paper or a piece of wet linen to the orifice; in this way it would appear that many sword-thrusts traversing the limbs were healed in a few hours or days. The process of suction cleared the wound thoroughly of all blood, and, drawing the sides into close apposition, placed the parts in the most favorable condition possible for union by adhesion. This practice might, perhaps, in many cases be advantageously imitated in the present day by means of a cupping-glass and syringe.

Amongst the varieties of punctured wounds that are most commonly met with in ordinary practice, are those which are occasioned by needles penetrating into, and breaking off in the body. These accidents chiefly occur in the fingers and feet, and about the nates; and, though trivial, are often extremely troublesome, both to Surgeon and to patient. When the Surgeon is called shortly after the occurrence of the accident, he must endeavor to remove the fragment left behind, by cutting down upon it. In doing this he will be guided by the situation of the puncture, and by the seat of the pain, and sometimes by feeling the point projecting under the skin. In many cases this is a sufficiently simple proceeding; in others, however, a deep and troublesome dissection may be required, especially when the fragment of needle gets into or under

the sheaths of a tendon. I have had occasion to undertake somewhat troublesome dissections between the biceps tendon and the brachial artery, or in the close proximity of the ulnar artery, for the removal of fragments of needles lodged in the bend of the arm and the wrist. For the purpose of extracting needles, thorns, splinters of wood, and other foreign bodies of small size and pointed shape lying in narrow wounds, the forceps shown in the annexed woodcut (Fig. 81) will be found most serviceable, as they have very fine but strong and well-serrated points. One of the most dangerous situations for a needle to penetrate is into the anterior part of the knee-joint, lodging on the head of the tibia or the patella, and breaking off short. In such cases the broken fragment should be dissected out at once, the limb put on a splint, and the ice-bag applied, so as to check inflammation of the joint. I have known the most disastrous and disorganizing inflammation and suppuration of the knee-joint ensue, with imminent peril to life, and followed by ankylosis, in consequence of a portion of needle having been allowed to remain embedded in this situation for some days.

Fig. 81 — Forceps for removing Small Pointed Bodies.

In many cases, if the needle have been lodged for some days, the Surgeons will fail in his endeavors to extract it; and, unless the indications of its presence be very clear, I think the wiser course would be to leave it undisturbed, and to trust to nature for its expulsion from the body, as it can seldom be found when sought for, and, indeed, may not exist, although supposed to be present. The following plan of ascertaining whether a portion of needle be really impacted has been suggested by Marshall. A powerful magnet is to be held upon the part for a quarter of an hour, so as to influence the fragment; a finely hung polarized needle should then be suspended over it, when, if any iron be present, deflection will ensue.

When a fish-hook, crochet-needle, or other barbed instrument has been run into the flesh, no attempt should be made to withdraw it through the aperture by which it entered, but the point should be pushed on so as to emerge through the skin, the shank then divided by pliers, and the barbed end drawn out.

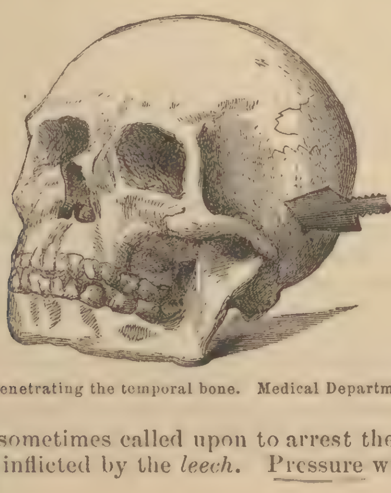


Fig. 82.—Indian Arrow penetrating the temporal bone. Medical Department, United States Army.

The Surgeon is sometimes called upon to arrest the bleeding from the punctured wound inflicted by the *leech*. Pressure with a piece of fluffy

lint for five or ten minutes usually suffices, or the bite may be touched with a point of nitrate of silver; but, if this do not arrest the bleeding, a needle should be passed across the bite, and a silk thread wound round it. The needle may be removed in twenty-four hours.

Arrow-Wounds occasionally fall under the observation of the military or colonial Surgeons as the result of injuries received in conflict with barbarous races. They differ only in one essential respect from penetrating punctured wounds received by knife-stabs and sword-thrusts, viz., that the arrow or its head will remain impacted in the tissues it has penetrated. The force with which an arrow may be shot is well illustrated in the accompanying figures (82, 83) taken from preparations in the Army Museum at Washington. The arrow shot from the bow of a North American Indian has been known to traverse the body of a buffalo and penetrate the under surface of its scapula, as illustrated by a preparation in the Museum at Washington.

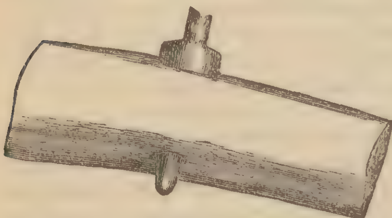


Fig. 83.—Buffalo Rib pierced by Indian Arrow. (U. S. Army Med. Dep.)

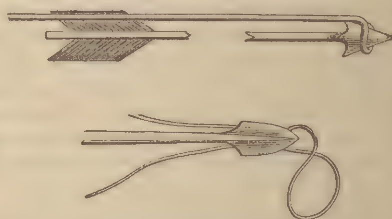


Fig. 84.—Bill's Snare for Extraction of Arrow Heads.

The extraction of an arrow is usually attended by little difficulty. But if barbed, or if the shaft becomes detached from the head, then special precautions have to be taken. With the view of effecting safely its removal, the "snares" figured (Fig. 84) have been devised. In the event of a large bloodvessel, artery, or vein being wounded in the head, thorax, or abdomen penetrated by the arrow, no special treatment is required beyond that which relates to the extraction of the missile.

CHAPTER X.

GUN-SHOT WOUNDS.

Of the special varieties of contused and lacerated wounds, none are of more interest than the different forms of gun-shot injury. Though comparatively rare in civil practice in this country, yet gun-shot wounds are of sufficiently frequent occurrence to render an acquaintance with them indispensable to the general Surgeon. To the military Surgeon the study of them is necessarily one of peculiar interest and importance; and to him I would specially recommend the perusal of the works of Paré, Wiseman, Hennen, Guthrie, Larrey, and Stromeyer, and of other Surgeons who have had unusual opportunities of studying the nature of these injuries upon the field of battle, and by whom they have been considered with all the minuteness of a speciality. I purpose in the fol-

lowing observations to confine myself chiefly to such a general discussion of the subject as is required by the civil Surgeon.

Gun-shot injuries constitute a species of contused and lacerated wounds, characterised in some cases by the peculiar appearance presented by the color, shape, and size of the orifice; and in others by the extensive injury inflicted on tissues, both superficial and deep-seated, in consequence of which the wounds may prove rapidly or immediately fatal. If the sufferer survive the immediate effects of the injury, high inflammatory action with much pain and tension, together with profuse discharge, deep-seated suppuration, and other serious and very protracted after-consequences, are apt to supervene. These peculiarities have at different times been attributed to the parts being burnt by the ball, to the poisonous nature of projectiles, to the generation of electricity in the bullet, during its passage through the air, or by its friction against the barrel. All these opinions, however, have been shown to be erroneous; and every peculiarity presented by these injuries can be accounted for by the bluntness of the contusing body, the rapidity of its motion, and the force with which it is driven. As John Bell has pithily remarked, "there is a peculiarity, but no mystery, in gun-shot wounds." That the sloughing which always occurs in the track of a bullet wound is due to the bluntness of the body with which the wound is inflicted, is evident from the fact that sharp splinters of shell have been known to inflict clean-cut wounds.

CHARACTERS.—Gun-shot wounds vary greatly according to the Nature of the Projectiles, to the Force with which they are driven, and to the Direction in which they strike.

Nature and Force of Projectile.—Gun-shot injuries of a serious character may be inflicted by *weapons charged only with powder*. They may arise from the mere concussion of the explosion; thus a pistol charged with powder, and discharged with the muzzle resting against the chest of a man, has been known to kill by concussing the heart. In other cases, a portion of the unexploded powder may be driven into or even through the skin by that which is exploded behind it. In this way, very troublesome and disfiguring marks are sometimes inflicted on the face, and other parts of the body, by the charcoal of the powder lodging in the skin. That a weapon so charged may actually kill when discharged at a little distance, appears from a case related by Dupuytren, in which a fowling-piece charged with powder only, and fired at the distance of two or three feet from the abdomen, pierced the belly with a round hole and killed the man. The mere force of the explosion will sometimes produce serious lacerations. Suicides occasionally forget to put a bullet into the pistol, and firing into their mouths, blow open the cheeks, and injure the pharynx and glottis by the explosive force. Some years ago, a man was brought to University College Hospital, who had discharged some powder from the tube of an *Italian iron* into his mouth, and died in consequence of the injuries he received. In another case in the same Institution, a man died on the fifth day after firing a pistol into his mouth, of asphyxia, occasioned by sloughing of the pharynx and inflammation of the glottis and larynx, consequent on the scorch of the explosion.

Wadding and soft materials, as pieces of clothing, will occasionally inflict serious wounds by the force with which they are driven. These injuries often happen on the stage, at reviews, fairs, &c. Taylor relates several instances of the kind:—one of a girl killed by a gun charged

with paper pellets; also, one of a man who was killed by a kid glove fired from a blunderbuss.

Small shot often inflict serious injuries, and these are most commonly met with in civil practice. If the person wounded be within a few feet of the muzzle of the gun, a terribly torn and lacerated wound, of a very serious character, even worse than that occasioned by a bullet, will be inflicted; for the shot, not being scattered, are driven through the body in a comparatively compact mass, and tear the tissues to a great extent. The compactness of a charge of shot when striking close to the muzzle of the gun may be very remarkable, making a wound like that of a bullet. A lad was admitted into University College Hospital under my care, who had accidently shot himself in the arm. The whole charge had passed from before backwards between the brachial vessels and plexus of nerves and the skin of the inner sides of the arm, leaving a bridge of skin about three inches in width and the vessels and nerves uninjured, the triceps, however, being torn. The patient made an excellent recovery.

When shots scatter as they fly, they produce at a greater distance a less serious injury, usually lodging in the subcutaneous areolar tissue, where they may remain for years, requiring to be picked out with a lancet; or they may give rise to suppuration. Occasionally, shot, by penetrating an important part, may cause serious or fatal results; thus, a single shot penetrating the eyeball will destroy vision; or, lodging in the heart or in the femoral vein or other large vessel, may give rise to rapidly fatal results. A patient was once brought to University College Hospital, who had fired a pocket-pistol loaded with small shot into his mouth; after death, the shots were found to have penetrated the anterior portion of the vertebral column, in which they were deeply lodged.

Splinters of shells inflict grave injury; as also do those of metal, wood, or stone, carried by the force of the explosion, as in blasting and mining operations. These latter inflict perhaps the worst forms of injury from bodies propelled by explosive force that are met with in civil practice. In siege operations much injury also is often inflicted by the splinters from parapets, or by the forcible throwing up of gravel and small stones by the explosion of shells. In naval actions, too, the force with which splinters of wood are driven, when struck and scattered by cannon-shot, is often so great as to inflict the most serious and fatal mischief. A particular form of injury sometimes met with in civil practice, and which belongs to this class, is a wound of the eyeball by the explosion and splintering of faulty percussion-caps. Wounds of the face and other parts from the splashes or splinters of bullets from the surface of targets, are of common occurrence among markers at rifle-ranges.

Bullets, slugs, and **grape-shot,** occasion more serious wounds than any that have yet been described; lacerating soft parts, fracturing and crushing bones, tearing asunder vessels and nerves, perforating the viscera, and occasionally cutting off parts, as a finger, the nose, or an ear.

The general introduction of rifled fire-arms into modern warfare has greatly increased the destructive effects of bullets. The missile is now comparatively rarely deflected from its course by the resistance offered by bones, tendons, or by the elastic reaction of the skin, as happened with the spherical ball, but penetrates in a straight line from the point struck, tearing through the soft parts, and splintering the bones extensively. On the bones especially, the modern *conico-cylindrical bullet*

produces the most destructive effects; not only comminuting the part struck, but often splitting up the shaft of the bone, by its wedge-like action, in fissures many inches long, leading into contiguous joints. (Fig. 85.) In consequence of the greater and more sudden disorganization of the soft parts, the shock to the nervous system is greater when a person is struck by a conico-cylindrical than by a spherical ball.

Fig. 85.—Perforation of the Right Femur by Bullet. Longitudinal Splitting of Bone. (United States Army Museum.)

Direction.—In the majority of cases, a bullet traverses, and the wound has two apertures, one of entry, the other of exit; occasionally it happens, however, that in consequence of the ball being spent, or of the piece not having been efficiently loaded, or of the oblique direction with which the ball strikes the part, it merely leaves a contusion or dent, rebounding or glancing off. In other cases there is only one aperture; and here the bullet, partly spent, has probably lodged in the soft tissues, or in a bone, or in the cavity of a hollow organ, as the bladder. It sometimes happens, however, that the ball drops out through the aperture at which it entered, as when a spent ball strikes a rib; or that it carries a pouch of clothing before it, which enables the Surgeon to withdraw it. One bullet may even make more than two apertures: thus a ball has been known to split against the sharp edge of the tibia, and to have one aperture of entry and two of exit; or it may pass through both thighs or both calves, and thus occasion four apertures; and cases have been recorded in which five wounds even have been made in the same person by one bullet. Conico-cylindrical balls, as has been already observed, tear their way through the strongest and densest osseous structures.

The direction of the openings is often of importance in the medico-legal as well as in a surgical point of view. Thus, Sir Astley Cooper, by attending to this circumstance in a case of murder, ascertained that the fatal shot must have been fired by a left-handed man; and this led to the detection of the criminal. These apertures, though usually opposite to one another when a ball passes right through a part, are not always so, the bullet being deflected by the bones, or by the elasticity of the skin, so that the two apertures do not correspond. Thus a bullet has been known to strike a rib and to be then deflected, running under the skin to the opposite side of the body; again, striking one temple, a bullet has been carried under the scalp to the other side of the head, where it has passed out; thus it might appear, that important cavities had been penetrated when in reality they had not been wounded.

The **Apertures of Entry and of Exit**, made by a bullet, deserve attentive consideration. Much discussion has arisen as to whether there be any difference between these apertures, and, if so, to what it is owing. That there is a difference in the great majority of cases, there can be no doubt; though this difference is, as a rule, not so decided in the case of the modern rifle-ball as in that of the spherical. Thus in the latter instance, the

Fig. 86.—Gun-shot Wound. Aperture of Entry.

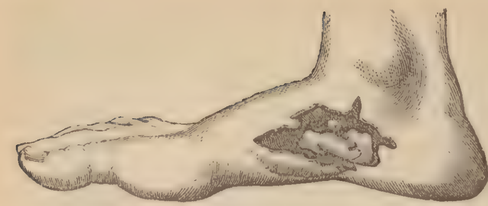


Fig. 87.—Gun-shot Wound. Aperture of Exit.

hole made by the entrance of the bullet is small, circular in shape, less than the diameter of the ball in breadth, the edges being slightly inverted and ecchymosed (Fig. 86); whereas, in the former, the aperture of entry is more lacerated and irregular in outline, often linear, crucial, or starred, and larger than the diameter of the ball. In either case, the hole made by the exit of the ball is a large. somewhat everted, and irregular aperture, into which two or three fingers may be freely passed (Fig. 87). In some cases, however, there is no appreciable difference between the two; and in others, after a time, the aperture of entry is larger than that of exit.

There can be no doubt that Guthrie has given the correct explanation of these discrepancies, when he states that the amount of the difference in the two apertures will depend partly on the momentum of the ball, and partly on the resistance with which it meets If the ball strike shortly after its discharge, at the maximum of its velocity, it will make but a small round hole. not shattering the parts so much as separating them. If it traverse a part composed of soft tissue, meeting with but little resistance in its passage, it loses but little of its momentum; and passing out of the body with nearly the same force as that with which it entered, it makes an aperture of exit that differs but slightly, if at all, from that of entry. If the ball strike a bone in its passage through the limb or body, and thus, by meeting with much resistance, have its momentum materially lessened, the aperture of exit will be torn, large, and ragged, differing materially from that of entry. But in addition to the conditions given by Guthrie, there are two other circumstances that tend to occasion a difference between the apertures of entry and of exit. The first is, that the bullet as it traverses carries with it a mass of foreign material, pieces of clothing, shreds of tendons, splinters of bone, which, driven along by the velocity communicated to them by the ball, distend and widely separate the distant parts of the wound and thus cause the aperture of exit, near and in which they will be found to be lodged, to be larger than that of entry, which has only admitted the bullet. The aperture of entry is made solely by the ball. The aperture of exit is made by it, plus the débris that it carries along with it. An additional reason for the difference in size between the two apertures is this, that the wide tearing asunder of the tissues at the aperture of exit is greatly due to their want of support. The part first struck has a support the whole thickness of the limb or the body. That which is last perforated has no such support behind it, and is thus largely torn or splintered outwards. This is exactly what happens if we drive a nail through a board. If supported by another piece of wood, the apertures on the two sides are even and of the same size. If unsupported, the aperture in the distant side, that of exit, in fact, will be splintered, irregular in shape, and larger than that of entry.

In bullet-wounds the entrance-aperture is actually less in diameter than the bullet itself, provided it be made whilst the ball is moving with its full velocity; but if the ball have lost much of its momentum before it strikes, then the entrance-wound will always be large and ragged. In this there is nothing peculiar to the tissues of the living body; the same

happens when any elastic material, as a piece of green timber, is struck. Much, however, will also depend on the period at which the wound is examined. In the early stages, for the reasons mentioned, the wound of entry may be smaller than that of exit; but, as the eschar which forms in the wound of entry is larger than that at the exit-aperture, the former may, in a later stage, appear larger than the latter. This difference in the size of the two wounds I saw well exemplified in the case of a young man, shot through the neck in a duel, with a pistol-ball. The aperture of entry, which was at first the smallest, appeared on the second day the largest in consequence of the extrusion of a black eschar; though it continued more regular in shape than that of exit.

Cannon-balls inflict two kinds of injuries. They may contuse a part deeply, crushing muscles and bones, without destroying the integrity of the skin, the ball either having lost its velocity, and being spent, or striking obliquely, or rolling over the surface of the body. The elasticity of the skin preserves this from injury, though all the subjacent textures—bones, muscles, and vessels—may be totally disorganized and crushed into a pulp, if a limb be struck; if the trunk itself be uninjured, the vertebral column and lumbar muscles may be disorganized, and the liver, kidneys, spleen, stomach, and intestines ruptured without any breach of surface. These injuries, formerly erroneously attributed to the action of the current of air set in motion by the ball, are known by the name of *wind-contusions*. Subcutaneous contusions of similar character, though less severe in degree, may also be produced by bullets. In some of these contusions gangrene of the limb sets in; apparently, as Guthrie has pointed out, from the rupture of the principal vessels. Cannon-shot more commonly carry away the whole thickness of a part, tearing and shattering a limb, carrying off the thick and fleshy parts of thigh, calf, or shoulder; or they may inflict the most fearful injuries by smashing the trunk and head.

Fragments of **shell**, particularly if large, inflict wounds equally destructive to life and limb. A small fragment may either become lodged, or make its way out, the aperture of entry being somewhat incised, though very irregular, and the aperture of exit large and rugged.

Symptoms.—The chief peculiarities of gun-shot injuries consist in the amount and character of the Pain, the severity of the Shock, the comparatively little liability to Hæmorrhage, and the severity of the Consecutive Inflammation.

The **Pain** in gun-shot injuries varies greatly. It is most severe when a bone is fractured, or a large cavity penetrated; when soft structures alone are injured, a dull and heavy sensation is experienced, which has often been compared to that occasioned by a blow with a stick. In many cases, however, the sufferer is not aware that he is shot till he is told of it. I have known a person shot in the leg by a pistol-ball, and not know that he was wounded till told that his leg was bleeding. This is especially apt to happen when the mind is actively engaged, as in the height of battle; no pain is experienced, and the sufferer does not know that he is wounded until he is told so, or sees the blood. Hennen has known a limb carried off or smashed to pieces by a cannon-shot, without the sufferer being conscious of it; and Macleod relates the case of an officer who, in the Crimea, had both legs carried away, and who was not aware of the injury till he tried to rise.

In gun-shot injuries, the **Shock to the Nervous System** is always very great where parts of importance, as the head, chest, and abdomen, or large joints, as the knee, are opened; and the severity of the shock is

indicative of the amount of mischief inflicted. As has already been stated, the shock is more severe when a wound is inflicted by a conical bullet from a rifle, than when made by a spherical ball from the old smooth-bore. Thus, if a bullet appear to have traversed the chest, but in reality has been deflected under the skin, the comparative absence of shock will serve, to a certain extent, to prove that visceral mischief has not been inflicted. In some cases the shock alone appears sufficient to kill; thus, a man shot by a pistol-bullet, which traversed the distended stomach, died in a few seconds from shock, there being no bleeding of importance, or other discernible cause of immediate death (Taylor). In some cases, however, that are mortal, the symptoms of shock are but slight.

The **Primary Hæmorrhage** from gun-shot wounds varies necessarily according to the situation of the injury and the size of the vessels injured; *cæteris paribus*, these wounds bleed less than other injuries; but in all cases a certain and in many a large and fatal quantity of blood is lost. When the fleshy parts of a limb are perforated by a bullet, the hæmorrhage is usually very trifling, the vessels divided being small, and contused rather than cut across If the whole of a limb be torn away by a cannon-shot, the arteries of the jagged stump do not bleed, for the same reasons that those of a limb torn away by machinery do not; viz., the contraction and retraction of the ruptured internal and middle coats, and the twisting of the external cellular coat over them. This explanation is disputed by Verneuil, who has described instances where, in severe gun-shot and shell-wounds of the leg requiring amputation, the arteries had all their coats cut through at the same level, and yet hæmorrhage did not occur. But, though it may be stated as a general rule that gun-shot wounds do not bleed much, yet when a large artery, as the carotid, iliac, or femoral, is cut across, violent and suddenly fatal hæmorrhage will occur—the vessel bleeding as freely as if divided with the knife. Bullet-wounds of the large and deep arteries of the chest and abdomen are almost immediately fatal from hæmorrhage. The greater number of those who die on the field of battle perish from this cause. It has often been observed that arteries escape, though lying apparently in the direct track of a ball. In such cases, however, though primary hæmorrhage do not occur, the liability to secondary hæmorrhage is great, in consequence of the artery which has been contused by the passage of the bullet sloughing at a later period.

Gun-shot wounds always **Inflame**, with much **Swelling, Infiltration**, and **Tension.** The pain which, at the moment of infliction, may have been but slight, becomes extremely acute when inflammation has set in, owing principally to the great tension. This, indeed, is one of the most remarkable phenomena of gun-shot injury, and, by giving rise to strangulation of the tissues, is often the cause of serious mischief. The inflammation speedily terminates in suppuration, often most profuse and extensive, not only in the track of the ball, but widely diffused through the neighboring parts. A period of great danger in gun-shot wounds is that about which the sloughs begin to separate, usually from the sixth to the twentieth day; and before this time it is often impossible to ascertain the precise extent of the disorganisation. At this period, also, **Consecutive Hæmorrhage** is very apt to come on, even after very slight exertion, without any warning. Baudens states that this occurrence is most likely to happen on the sixth day. This may be suddenly fatal, and is always more dangerous than the primary hæmorrhage, not only on account of the difficulty of arresting it, but because

the patient has been already weakened by severe inflammation and suppuration. Secondary hæmorrhage may occur from other causes than the separation of the sloughs and the consequent opening up of a contused or inflamed artery. It may take place from an artery wounded by a spiculum of fractured bone; and from the same cause it may arise at any period until all detached bone is separated and the wound firmly cicatrised. Chisholm, of the American Confederate army, mentions a case of death by secondary hæmorrhage on the 328th day after a gun-shot fracture of the upper third of the thigh, owing to a wound of the femoral artery by a detached sequestrum. Independently of this danger from secondary hæmorrhage, the patient, if his limb be saved, may have to undergo long and tedious processes of exfoliation of dead bone, and to run the risk of intercurrent attacks of erysipelas, hospital gangrene, and visceral mischief.

There is every reason to believe that warfare in modern times is fully as destructive to life as it was formerly, if not much more so; not in the proportion of the killed to the number of combatants engaged, but in relation to the recoveries among the wounded. This at first sight appears remarkable, when we consider the great advances that have of late years been made in the surgical treatment and in sanitary arrangements. But it is readily explained by the facts that the size and form of the projectiles now used, and the forces with which they are driven, are such as to render the wounds inflicted by them infinitely more destructive than they used to be; and that the advance in surgical treatment is thus more than neutralised by the more deadly nature of the injuries, whilst the enormous number of men engaged has yielded so large a proportion of sick and wounded that, after the first few weeks, the sanitary arrangements have hitherto broken down under the pressure, and secondary septic diseases have committed the most frightful ravages. The complete surgical statistics of the great Franco-German war have not yet been made public, but, so far as can be ascertained, there can be but little doubt that the result of excisions and amputations, as well as those attending the treatment of compound fractures, were far less satisfactory than in other recent wars.

Treatment.—The slighter and purely superficial gun-shot injuries generally merely require to be treated on the ordinary principles that guide us in the management of contusions and lacerations generally. When they affect the head, chest, or abdomen, they present so many circumstances of special importance, that we must defer the consideration of them until we treat of injuries of those regions.

In all cases of gun-shot wound, whether amputation be ultimately required or not, certain *immediate attentions* are necessary in order to place the sufferer in some degree of comfort and safety. Thus, if a person be shot through the fleshy part of a limb, no bone or vessel of importance being injured, the part should be covered with wet cloths, and placed in an easy position. If there be abundant venous hæmorrhage, the limb should be raised; and if this do not arrest the bleeding, a compress should be used. If the hæmorrhage be arterial, a tourniquet must be applied. So, also, a tourniquet should be employed if there be rapid dripping of blood.

If a limb be smashed, or torn away, a tourniquet should be applied very tightly upon the stump, which must be covered up in wet cloths. The pressure of the tourniquet will not only arrest hæmorrhage, but will stay that spasmodic quivering of the muscles of the mangled limb which is so painful to the sufferer.

If the head or neck be wounded, cold wet pledgets should be applied, and hæmorrhage, whether venous or arterial, should be arrested by pressure with the fingers.

If the chest be shot through, the patient should be laid on the injured side, and cold employed. If emphysema occur, or if air freely pass through the wound, a body bandage must be tightly applied.

If the abdomen be wounded, the patient should be laid on the injured side, if the aperture be lateral; if it be central, on his back, with the knees bent over a log or knapsack, or other support. If the intestine protrude, it must be washed and returned at once.

In addition to those immediate attentions, which may be bestowed upon sufferers from gun-shot wounds before they are sent to the hospital for more methodical treatment, the influence of the shock should be counteracted by the administration of a little brandy-and-water, and plenty of cold water should be given to allay thirst.

Gun-shot Wounds of the Extremities may be divided into two great classes in reference to treatment:—I. Those that do not require amputation; II. Those in which amputation is necessary.

I. Those cases of gun-shot injury that **do not require amputation** must be treated on the principles that guide us in the management of all contused and lacerated wounds; the Surgeon bearing in mind, however, that these injuries are especially apt to be followed by extensive and intense inflammatory action, and that sloughing will inevitably result in every part that has been touched by the ball.

Fig. 88.—Gun-shot Wound of Thigh; Mode of Compressing Artery temporarily.

The first point to be attended to in these cases is the **Arrest of Hæmorrhage.** In general, this may not give much trouble; but, if a large vessel be injured, the loss of blood will rapidly prove fatal, unless immediately stopped. The bleeding may in the first instance be stopped by direct pressure with the fingers on the bleeding part, followed by the application of the tourniquet; or, if this instrument be not at hand, of some simple substitute, such as a pebble, of about the size of an egg, rolled in the middle of a pocket-handkerchief and laid over the artery, the ends of the handkerchief being knotted round the limb, and then twisted up tightly with a piece of stick or the hilt of a sword passed under it (Fig. 88). The wound in the artery may render amputation of the limb necessary; if not, hæmorrhage must be permanently arrested by making an incision down to the bleeding vessel, and applying a ligature on each side of the wound, for reasons that will be fully stated when we come to speak of Injuries of Arteries. In military practice such operations, however, appear to be very rare, and the ligature of a large artery for primary hæmorrhage after gun-shot injury is scarcely ever practised. The fact is that, if a large artery be wounded, the patient usually dies outright from hæmorrhage before anything can

be done to arrest it. If a small vessel only be divided, the hæmorrhage will speedily cease of itself.

The second point to be attended to is the **Extraction of Foreign Bodies**, such as shot, slugs, or bullets, wadding, pieces of clothing that have been carried in with the ball, splinters of bone, and other matters of a like kind. These will generally be found near the aperture of exit, through which they may often be more easily extracted.

If the *bullet* lodge, it, together with foreign bodies accompanying it, such as pieces of clothing, must be extracted through the wound, or cut out by a counter opening. This second opening is often of great utility in affording a ready exit for subsequent discharges, &c. Palpation of the limb or region struck will often lead to the discovery of the bullet, when it lies amongst the muscles or beneath the skin. A consideration of the direction whence the bullet came, and the position of the patient when hit, will often direct attention to the spot where the ball has lodged. If possible, the same position of body or limb should be assumed; the track of the bullet will thus be straightened, and the finger or probe can be carried down to it more readily. In searching for bullets and other foreign bodies, care must be taken not to probe the wound unnecessarily from mere curiosity, or so as to excite irritation; in many cases, the introduction of the finger is far more useful than that of the probe. The advice given by Ambroise Paré, three hundred years ago, with regard to the examination of gun-shot wounds, can scarcely be improved upon. After advising that the examination of the wound be made as soon after the injury as possible, before swelling and inflammation set in, he says: "This is the principal thing in the performance of this work, that you place the patient in just such a posture as he was in at the receiving of the wound; for otherwise the various motions and turning of the muscles will either hinder or straighten the passage forth of the contained bodies. You shall, if it be possible, search for these bodies with your finger, that you may the more certainly and exactly perceive them. Yet if the bullet be entered somewhat deep in, then you shall search for it with a round and blunt probe, lest you put the patient to pain." The *extraction of the bullet* should be accomplished without delay, before inflammation has set in, and the lips and sides of the wound have become swollen. As Macleod justly observes, the extraction of the ball not only removes a source of physical irritation and suffering, but also of mental disquietude. The mind of the patient becomes more tranquil and easy. Bullets cannot be allowed to remain lodged in the body with impunity. It is true that in some cases they become encysted, and so cease to irritate; but in the great majority of instances they produce suffering and constitutional disturbance, and may at last occasion fatal mischief; for, although a bullet may continue fixed for years, yet it may at last, under the influence of muscular action, gravity, or the absorption of fat, begin to move and to give rise to injurious consequences. If any foreign body be very tightly fixed, so that it cannot easily be removed, it must be left till loosened by suppuration. Sometimes a bullet is firmly fixed in the cancellous structure of the articular end of a bone. It may be removed thence by means of an elevator or by the screw-pole.

Various instruments are used for the detection and removal of bullets and other foreign bodies. There is usually no material difficulty in detecting the presence of a bullet, by means of an ordinary steel probe of sufficient length. In some cases of peculiar and exceptional difficulty, where the bullet is lodged deeply in the cancellous structure of a bone, or amongst swollen and infiltrated tissues, its presence may be detected

by the ingenious device adopted by Nélaton, in the case of Garibaldi, of passing a probe armed with a piece of unglazed porcelain down to the suspected site of the bullet, and seeing if a streak of lead were left on the rough surface of the china (Fig. 89). Bullet-detectors have also been contrived, in which, by an arrangement of two isolated metal probes in a cannula connected with a galvanometer, the galvanic circuit is completed when the bullet is touched, and the needle of the galvanometer deflected; or, instead of the latter instrument, the ordinary telegraph alarum may be interposed. For the removal of bullets, long and strong forceps are required, the action of which may be aided by a screw-probe. The accompanying woodcuts (Figs. 90, 91, 92, 93, and 94) represent the best forms of bullet-screws, forceps, and extractors.

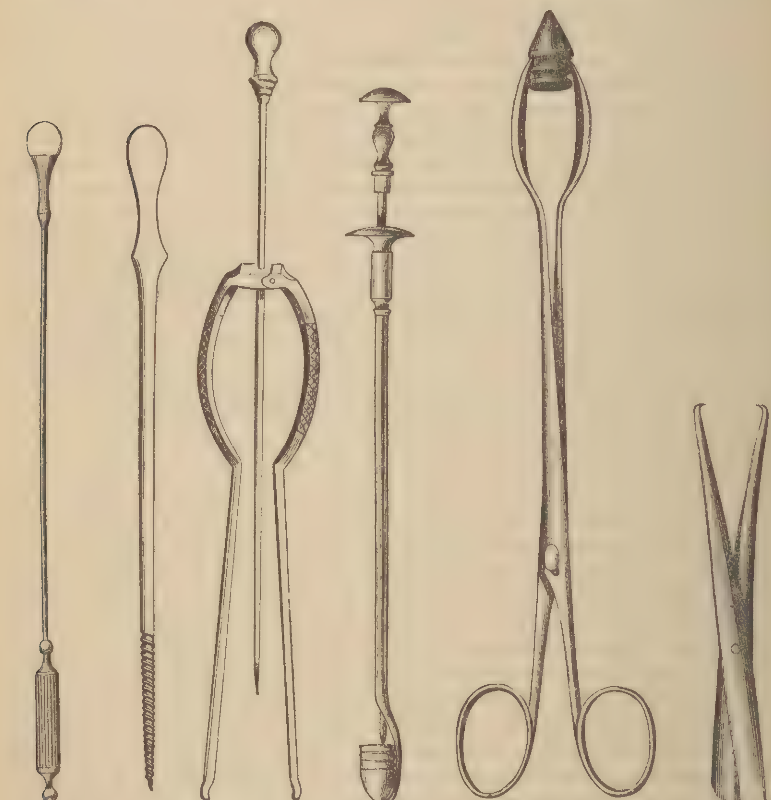


Fig. 89. Nélaton's Probe.

Figs. 90, 91, 92 —Bullet-screw, Forceps, and Extractor.

Fig. 93. —Bullet-forceps.

Fig. 94. Hook Splinter-Forceps.

The *splinters* produced by the passage of a ball through a bone are more numerous and larger, when the injury has been inflicted with a conicle rifle ball. The impetus of this projectile is so great, and its wedge-like action so destructive, that the bone struck is shattered into a number of fragments, as well as split longitudinally, often to a great extent. These fragments are detached to a greater or less extent from their connection with the soft parts, and carried out of the axis of the

limb. Dupuytren, who was fond of systematizing, has classified splinters of this kind under the three heads of *primary*, *secondary*, and *tertiary*. By *primary* splinters are meant those which are carried completely across the limb, detached from the soft parts, and lodged near the aperture of exit. The *secondary* splinters are those which are still attached by a strip of periosteum or fibrous tissue; and the *tertiary* are those portions of bone which, from the violence done to them, often necrose and separate at a subsequent period. The treatment of these different kinds of splinters must necessarily vary. The primary, which are already completely detached and are incapable of consolidation, must be treated as foreign bodies and extracted. The secondary, if very loose, must also be removed; but, if more firmly fixed, they may be pushed into the axis of the injured bone and left, when they may become consolidated by callus, and so serve in the reconstruction of the bone. The tertiary, which do not separate until about six or seven weeks, must be removed as soon as possible; if they become engaged in a mass of callus, it may be a considerable time before they are loose enough to be removed; and, until then, sinuses leading down to them will remain open even for years.

The reunion of comminuted gun-shot fractures may be assisted by the resection of the fractured ends of the bones in appropriate cases. This plan has been especially successful in the bones of the upper extremities. The ends thus resected may furthermore be kept in apposition by metallic sutures, according to the plan suggested by Howard, of the American army.

In those cases in which small shot are lodged under the skin, they may be turned out by being cut down to with a fine scalpel.

The **Treatment of the Wound** itself must be conducted on ordinary surgical principles. As has already been stated, there will, as a rule, be violent inflammation and sloughing along the whole track of the ball; although instances have been recorded of primary union in gun-shot wounds uncomplicated with fracture or the lodgment of foreign bodies. The principal points to be attended to are, consequently to limit the inflammation, to watch and facilitate the separation of the sloughs, and to pay scrupulous attention to cleanliness.

By adopting in suitable cases, and under circumstances where the requisite time and attention can be spared, the antiseptic method, both inflammatory action and the formation of sloughs may be avoided. Under this treatment, repair of gun-shot fracture without suppuration or sloughing has in at least one instance been reported. In any case, no harm can accrue if the first dressing be conducted after that plan; if suppuration then ensue, it may still be treated by the usual methods without detriment to the patient who will have had the chance given him of escaping the sufferings and exhaustion attendant on the healing of an extensive wound by the second intention.

In order to *limit the inflammation*, it was common practice with military Surgeons, and still is so with the French, to enlarge by incision the wound made by the ball, with a view of preventing tension and strangulation of parts. Since the time, however, when John Hunter pointed out that an incision could not alter the nature of a contused wound, and only superadded another injury to the one already inflicted by the bullet, British Surgeons have employed the knife, in the early stages of gun-shot wounds, only for the purpose of facilitating the securing of bleeding vessels, or the extraction of foreign bodies. In the more advanced stages, however, free incisions, which should be made in the direction of the axis of the limb, are commonly required in order to lessen inflam-

matory tension, to prevent the extension of sloughing, and to favor the escape of discharge.

The best mode of lessening inflammation in a gun-shot wound in the early stages, and more especially in hot climates, is either cold irrigation or the application of dry cold by means of ice in India-rubber bags, conjoined with position and rest; at a later period, water-dressing and poultices will be more useful. As suppuration comes on, we must substitute warm applications for the cold, so as to hasten the formation of matter and the separation of the sloughs, whilst disinfectants should be freely used to the whole cavity of the wound. All bagging and burrowing of matter must be carefully guarded against by position and pressure and drainage, and, if need be, a counter-opening. Free incisions may also now be required. These should not be delayed too long. They may be required for two purposes; first, to remove the tension resulting from deep infiltration of the limb by inflammatory effusions, and by that means to prevent the strangulation of the tissues, and remove the severe constitutional reaction that is always consequent to and dependent upon this local inflammatory tension; and secondly, to open up purulent collections, which often depend upon the irritation of splinters, portions of clothing, and other foreign bodies that could not be removed in the first instance. When the inflammatory action runs very high and will not yield to the measures just enumerated, it may be necessary to compress or to tie the main artery leading to the part. At the period of the loosening and separation of the sloughs, there is always especial danger of the supervention of consecutive hæmorrhage. The patient, consequently, at this time requires to be carefully watched: if the wound be in the vicinity of a large vessel, a tourniquet should be placed loosely round the limb, so as to be screwed up at a moment's notice; and, on the supervention of bleeding, the artery must be ligatured, if possible, at the seat of the wound, or, if this be not practicable, in the most convenient situation above it; and if this do not arrest the bleeding, recourse should be had to amputation. In secondary hæmorrhage following gun-shot wounds, Neudorfer recommends the employment of a temporary ligature. The method adopted by him consists in exposing the artery exactly as in the ordinary operation for the ligature; a silk thread or a wire is then passed round the vessel, and the two ends are carried separately through the soft parts of one side of the wound, so as to appear about half an inch from the edge, and about half or three quarters of an inch apart. The ends are then fastened to a half cylinder of cork, and are left from forty-eight to seventy-two hours, when they are removed.

Serious results, such as abscesses, profuse discharges, necrosis, osteomyelitis, and the separation of splinters of bone, must be subsequently looked for in many cases; and these results may be prolonged for many years, at last perhaps wearing out the patient if the cause of irritation be not removed. Thus General Bem required to have a bullet removed by Liston from the external condyle of his femur, nineteen years after it first lodged there; and Marshal Moncey died forty years after the receipt of a gun-shot wound, from its effects. A soldier who was wounded at the storming of the Redan, died under my care in the Unisity College Hospital, two years and a half after that event, of exhaustion resulting from a large lumbar abscess. On examination it was found that the bullet, which had entered the left side of the chest and wounded the lung, traversed the diaphragm, notched the spleen, passed between the kidney and suprarenal body, and perforated the spine, was

lying encapsuled on the right side of one of the vertebræ, pressing upon the right renal vessels. Its irritation, and that of the sequestra from the injured spine, produced the abscess, from the effect of which the patient died.

The aperture of exit always heals sooner than the aperture of entry; owing, probably, as Neudörfer observes, to the bullet having lost its lateral action in its passage through the tissues, and merely cutting its way out. It is at the point, he remarks, where the lateral action is lost, that healing begins.

II. **Amputation** is required in gun-shot injuries in two classes of cases of very dissimilar character.

In cases where the limb has been wholly or in part carried away, or where it is evidently hopelessly shattered, the ragged, conical, and quivering stump, or the mangled remains of the limb, must be removed. In such cases there can be no doubt whatever in the mind of any Surgeon, as to the necessity for immediate amputation.

But there is another class of cases, where amputation is also very commonly required, though, to a Surgeon judging solely from the accidents of civil life, it might not at first appear necessary. These are, especially, cases of *compound gun-shot fractures of the thigh*, *bullet-wounds of the knee-joint*, and many similar injuries of the leg. Injuries such as these, occurring from other causes in civil practice, might admit of an attempt being made to save the limb. But in military practice it is different: here the attempt to save the limb may be followed by such extreme local and constitutional disturbance as to jeopardise seriously, and probably to destroy, the patient's life. In such circumstances, conservatism is often a fatal error, and to save life the limb must be sacrificed. The injury for which an experienced army Surgeon knows that amputation is imperative, may look but trifling, and to the patient himself, or to the civilian, may appear to justify treatment by less severe procedure; but experience has incontestably shown that in amputation is almost the only chance of safety in gun-shot wounds of the lower third of the thigh and of the leg, fracturing the bones, or injuring the knee-joint. Dupuytren states that, in rejecting amputation in compound fractures of the extremities from gun-shot, we lose more lives than we save limbs; and Hennen is of opinion that in all "ambiguous cases" amputation should be performed.

The following is a specification of the chief conditions in which amputation is required.

1. When the whole limb is carried off, a ragged stump merely being left; so, likewise, if the limb be completely crushed and disorganised, whether by direct blow or by a "wind contusion" though still left adherent; or again, if the principal vessels be injured and the soft parts carried away, though the bone be intact, the limb cannot be preserved.

2. Amputation is especially necessary in some of the more serious injuries of the lower extremity; thus, if a bullet divide the femoral vessels or the sciatic nerve, and splinter the thigh-bone; or if the sciatic nerve and soft parts at the back of the thigh be carried away, although the vessels and bone be left uninjured, the case is one for amputation; and, indeed, it may be stated generally (though, doubtless, there are exceptions to this, as to all general rules in surgery) that all *compound fractures of the lower third of the femur* occasioned by gun-shot require amputation. The mortality, however, after amputation for gun-shot injury of the *upper two-thirds of the thigh* is so very great, that many Surgeons have abandoned the operation in these cases, and professional

opinion is unsettled as to the course that should be pursued. In the Schleswig-Holstein war of 1849, it became a question with many of the German and Danish Surgeons whether this operation should be continued, or whether the patient would not have a better chance if the injury were treated on ordinary principles as a compound fracture. At the siege of Sebastopol, the mortality after amputation of the upper third of a thigh was so great in the Russian army, that the Surgeons abandoned the operation. On the other hand, it is stated in the Report of the Black Sea Fleet, that to attempt to save the limb in any case of gun-shot fracture of the thigh was to endanger the patient's life. In the Crimea, Macleod states, that a bad compound fracture of the thigh from gun-shot was synonymous with death. This was partly owing to the bad health of the troops, and partly to the terrible effects of conical balls. In India, where round bullets and matchlock balls were more used, the result was not so bad.

Macleod states that, although he made every inquiry, he could hear of three cases only in which recovery had, in the Crimea, followed a compound fracture of the upper third of the thigh-bone without amputation. But, exceptional as were such recoveries, he states that they were not so rare as after amputation for similar injuries; as indeed was proved by the fact that not one patient recovered after amputation at the hip-joint. Hutin, the Surgeon to the Invalides in Paris, was able to discover twenty-four cases of recovery after compound fracture above the middle of the thigh, but no case of recovery after amputation for injury of the same part. In the British army in the Crimea, the amputations in the upper third of the thigh, which must have been for compound fractures low down in the bone, were fatal, in the ratio of 86 per cent.; of those in the middle, probably for injuries of the lower articular end and knee, 60 per cent. died; whilst of those in the lower third, which must have been for injuries of the knee and leg, the mortality was reduced to 56 per cent. The conclusions at which Macleod arrives after a careful inquiry into this question, are so important, that I give them in his own words. He says: "Under circumstances of war similar to those which occurred in the East, we ought to try to save compound comminuted fractures of the thigh when situated in the upper third; but immediate amputation should be had recourse to in the case of a like accident occurring in the middle and lower thirds." In the great civil war in America, the opinions of Surgeons appear to have been divided; and the conclusion arrived at seems to have been that, provided the large vessels and nerves were not injured, and the circumstances in which the patient was placed as to conveyance not too unfavorable, the chance of recovery would be equal whether amputation were performed or an attempt made, aided by the free use of antiseptics, to save the limb. But even in these circumstances Hamilton states that, although his experience in that great war has led him to the conclusion that in the upper third the life is at least hazarded by an attempt to save the limb, in the middle third conservatism and amputation afford an equal chance, whilst in the lower third of the thigh the chances are in favor of amputation. This is a conclusion very similar to that arrived at by British Surgeons. When an attempt is made to save the limb, an apparatus, the characteristic principle of which is continuous extension and counter-extension, with but few splints and bandages, should be used; so the limb may be securely fixed in the plaster-of-Paris apparatus.

3. In gun-shot fractures of the *bones of the leg*, amputation becomes necessary if the tibial arteries be injured, or if the knee or ankle-joint be

badly wounded. If the injury be in the middle of the leg, at a distance from these joints, and provided there be not longitudinal fissuring of the bone leading into them, much may be done to save the limb, by the extraction of splinters, and the removal of sharp and angular fragments of bone, the limb being put up in the plaster-of-Paris apparatus. In such cases, the patient may recover with a shortened but otherwise useful limb.

4. Gun-shot wounds of the *foot*, if perforating and splintering the tarsus, require amputation, either at or above the ankle. Those of the *hand* are of special interest from their frequency, in consequence of the bursting of guns, or of powder-flask explosions. In these cases, however extensive the injury may be that is inflicted upon the hand, fingers being blown away, the thumb thrown back, and the metacarpal bones splintered, we must endeavor, if possible, to save a portion of it, if it be only one or two fingers; and, owing to the great reparative power possessed by the hand, we shall often, in the worst-looking cases, be able to accomplish this. If the thumb, with one finger as an opponent, can be preserved, it will be of more service to the patient than any artificial contrivance, however ingeniously made. It not unfrequently happens that amputation may be required in the more advanced stages of gun-shot injury, in consequence of mortification. In these circumstances, it must be practised without delay, and without waiting for the line of separation. If, in consequence of long-continued suffering and discharge, the patient's health become greatly deteriorated, and the limb remain an useless appendage, amputation will at last be imperative.

5. Gun-shot injuries of *joints* are necessarily most serious and fatal—the danger depending on the size and complexity of the articulation, rather than on the extent of the injury. Wounds of any of the three large joints of the lower extremity are especially dangerous and fatal; those of the upper extremity are more readily, and indeed commonly, recovered from. The fact of a joint being wounded is generally obvious enough from the direction taken by the ball, the comminution of the bones, and perhaps the escape of synovia; but a joint may be fatally injured by the longitudinal splitting of the bone into it, although the bullet has not passed within some inches of it.

In bullet-wounds of joints, excision may be advantageously substituted for amputation in cases in which the soft parts are not too extensively torn, the large nerves and vessels are uninjured, and the shaft of the bone not too widely splintered, the mischief being chiefly confined to the articular ends. Excision

Bullet-wounds of the *head*, *neck*, or *trochanters of the femur*, splintering the bone into the articulation, are necessarily most serious. If they be left to palliative treatment, the death of the patient may be considered as almost inevitable; if amputation at the hip be performed, the prospect is better; and, though desperate, the case must not be considered as hopeless. This is well illustrated by the result of amputations in the great war of the American Rebellion (p 127). In *Primary* amputations at the hip-joint for gun-shot injury, the mortality was, according to one estimate, 94, according to another, and I think more correct, 84 per cent. All *Intermediate* amputations were fatal, the *Secondary* ones only at the rate of 77 per cent. If the shaft be not too much implicated, it is probable that the best hope lies in the excision of the splintered bone, and the careful removal of the loose fragments. This operation, originally proposed by Guthrie, and first successfully performed by O'Leary in the Crimean war, presents the most reasonable, though but Wrist

a slender, hope of safety to the patient, and should accordingly be practised. With this view the wound must be laid freely open, loose fragments extracted, and the upper end of the bone detached, turned out, and sawn off. Of six cases in which this was done in the Crimea, one patient, O'Leary's, recovered.

Bullet-wounds of the *knee-joint* are amongst the most serious injuries in surgery; and this whether the bones be much comminuted or not, provided the epiphysis of the tibia or femur be perforated, or the articulation be fairly traversed or even penetrated by the ball. Prior to the American war there were but seven cases in which excision of the knee had been done for gun-shot injury—five in military, two in civil practice; the two latter cases recovered, the other five died. In the American war the operation was done eleven times: in two cases, one primary, the other secondary, recovery took place; nine deaths resulted, chiefly from pyæmia. In three cases in which the patella alone was excised, death ensued. During the late war the results of excision of the knee, both primary and secondary, have been so uniformly bad that the operation for the future will probably be abandoned in military surgery. The operation would be doubtless advisable in cases of gun-shot wounds of the knee occurring in civil practice, where every possible care and attention can be bestowed upon the after-treatment, hygienic conditions, and diet of the patient; but where this is impossible, as after a great battle, it is almost certainly fatal, contrasting most unfavorably with primary amputation in the lower third of the thigh. When amputation is determined on, the operation requires to be performed early, not because the apparent injury may be very severe, or the mutilation of the limb so great as obviously and imperatively to call for immediate amputation, but because experience has shown that, unless the limb be removed at an early period, after-consequences of the most serious and fatal character will to a certainty ensue. Extensive suppuration of the joint, deep and large abscesses burrowing amongst the muscles of the thigh, and consequent exhaustion of the patient by hectic, or his destruction by pyæmia, are the conditions that amputation, performed at an early stage, can alone avert. This necessity for early amputation in penetrating bullet-wounds of the knee-joint is recognised by all modern military Surgeons. Guthrie and Larrey in the French wars, Esmarch and Stromeyer in the Schleswig-Holstein campaign, and the Surgeons in the Crimea, all found that the attempt to save a limb so injured led to the sacrifice of the patient's life.

Bullet-wounds of the *ankle-joint* do not necessarily require amputation. If the bones be not too extensively comminuted, and more particularly if the posterior tibial artery and nerve have escaped injury, an attempt, and probably a successful one, may be made to save the limb; the injury being treated on those principles which will be described in the chapters on Fractures and on Dislocations. In such cases extraction of fragments, and excision of the splintered ends, are necessary; and modified operations, partial excision by means of gouge, forceps, and Hey's saw, will be found more successful than the more systematic operations. If the large vessels and nerves have been cut across, and the bones very extensively shattered, amputation will be the proper course to pursue.

The *shoulder*, and more particularly the left shoulder from its advanced position in the act of firing, is peculiarly liable to gun-shot injury; the bullet either traversing the head of the humerus and lodging in it, or perhaps fracturing some of the bony processes of the scapula in its im-

mediate vicinity; or, as in the case of common shot, or fragments of shells, carrying away the fleshy cushion of the deltoid muscle. It is especially in bullet-wounds of the shoulder and elbow-joint, that conservative surgery has been most successful. In such cases, when the bones are penetrated, and even shattered by a bullet, provided the main blood-vessels and nerves of the limb be not injured, amputation will seldom be required; and, indeed, it should be laid down as a rule in surgery, that excision should be preferred to amputation in all cases, when the large blood-vessels and nerves are not wounded, or the soft parts too extensively disorganised. The wound having been enlarged, loose spicula must be removed, and the splintered and jagged ends of the fractured bone sawn smoothly off. If the bullet be still lodged in the head of the humerus, as in Fig. 95, the same course should be adopted. It has been a question with Surgeons, whether excision or amputation should be done when the upper end of the shaft of the humerus has been much splintered, with or without penetration of the joint. In these cases the epiphysis is often uninjured. Guthrie advised amputation; but the result of the experience of the war in America has been that five or six inches of the shaft of the humerus may be removed with perfect safety, and that no good comes of leaving the uninjured epiphysis, which should also be excised. The results of excision of the joints of the upper extremity are in the highest degree satisfactory. Thus Baudens states that he saved 13 out of 14 cases of excision of the shoulder. According to Thornton, in the British army in the Crimea, the shoulder was excised 12 times with 2 deaths; the elbow in 17 cases, of which two were fatal, and partially in 5 other cases, all of which were successful. These results, which reflect the highest credit on the skill of our army Surgeons, were more successful than those that followed the amputation of corresponding parts. Of 60 disarticulations at the shoulder, 19, or 31 per cent., were fatal; and of 153 amputations of the arm, 29, or 19 per cent., died. The result of resection of these joints has not been quite so satisfactory elsewhere: thus, in the Confederate army in America, Chisholm states that up to February, 1864, of 59 cases of excision of the shoulder, 20 proved unsuccessful, and of 45 cases in which the elbow was excised, 9 were unsuccessful. In the official report of the Surgeon-General of the United States army, of 286 cases of excision of the elbow in which the results are known, it is stated that 62 died, and that in 16 amputation became necessary. Of 210 primary excisions of the shoulder-joint death occurred in 50; and in 298 secondary excisions 115 cases were fatal, giving a mean mortality of 32.48 against 39.44 for amputation at the shoulder, and 44.4 for cases treated on the expectant plan. In the Russian army, conservative surgery was also extensively practised; and in it, according to Mouat and Wyatt's report, of 20 cases of excision of the elbow, 15 recovered

Fig. 95.—Bullet in Head of Humerus.

The operation of **Excision** of large portions of the shaft of the humerus as well as of its head, was carried much further by the American military Surgeons in the war of the Rebellion than had heretofore been done. Fig. 96, taken from photographs in the possession of the Army Medical Department at Washington, represents six inches of the shaft of the humerus with its head, which had been thus excised; and Fig. 97, the arm that was left. I saw the man, who is an orderly in that splendid and unrivalled collection, the Army Medical

Museum at Washington, and I can testify to the utility of his arm; the bone so skilfully taken away he himself exhibited.

Fig. 96.

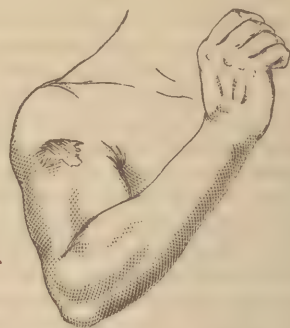


Fig. 97.—Result of Excision of Head, and six inches of Shaft of Humerus, shown in Fig. 96. (U. S. Army Med. Dep.)

Excision of the wrist, in whole or in part, for gun-shot injury has not proved very satisfactory, not so much from death as from inutility of the hand that was left. Of 27 done in the American war, only 3 died. In two instances, amputation of the fore-arm was practised.

The steps of all the excision-operations are the same, whether the excision of the part be required for gun-shot injury, or for other accidents, or for disease; except that in gun-shot injury advantage may often be taken of the wound in the soft parts, by enlarging which longitudinally, the shattered bone may be readily reached and extracted, and the splintered ends sawn smooth.

The question as to the *period at which amputation ought to be performed* after the infliction of gun-shot wounds, is one of great importance, and has given rise to much discussion among Surgeons. The older military Surgeons, Paré, Wiseman, Ledran, Ranby, &c., taking a common-sense view of the question, advocated the removal of the hopelessly injured limb as soon as possible after the receipt of the injury. Wiseman's advice is to "cut off the limb quickly, while the soldier is heated and in mettle;" and this advice has not been and cannot be improved upon. After the battle of Fontenoy, in the middle of the last century, professional opinion underwent a change upon this subject; and Faure wrote a thesis, which obtained a prize of the French Academy of Surgery, recommending delay in amputating in certain cases. Hunter, Percy, and other Surgeons of repute, promulgated similar views; until Bilguer, the Surgeon-in-chief to the armies of Frederick the Great, went to the absurd and dangerous extent of condemning amputation entirely. These extreme opinions necessarily occasioned a reaction; and the experience gained in the wars of the French Revolution and of the Empire, has enabled Surgeons to settle this question definitely. It is more particularly through the labors and observations

of John Bell, Larrey, Thomson, Guthrie, S. Cooper, and Hennen, that the necessity of having recourse to immediate amputation in all cases of gun-shot injury requiring this operation has been fully recognized, and the truth of Wiseman's advice has been re-established.

In determining this point we must be guided, partly by surgical experience of the result of such cases when left to nature, and partly by an appeal to facts. In appealing to experience we must, to use the forcible language of Sir Charles Bell, contemplate what will be the condition of the parts in twelve hours, in six days, and in three months. "In twelve hours the inflammation, pain, and tension of the whole limb, the inflamed countenance, the brilliant eye, the sleepless and restless condition, declare the impression the injury is making on the limb and on the constitutional powers. In six days, the limb from the groin to the toe, or from the shoulder to the finger, is swollen to half the size of the body; a violent phlegmonous inflammation pervades the whole; serous effusion has taken place in the whole limb; and abscesses are forming in the great beds of cellular texture throughout the whole extent of the extremity. In three months, if the patient have labored through the agony, the bones are carious; the abscesses are interminable sinuses; the limb is undermined and everywhere unsound; and the constitutional strength ebbs to the lowest degree."

If we appeal to facts, we shall find that of 300 secondary amputations reported by Faure, after the battle of Fontenoy, only thirty were successful; whereas Larrey saved three-fourths of his primary amputations in the Napoleonic wars. In the Peninsular war, the comparative loss after secondary amputations of the upper extremity, was, to that following the primary, as twelve to one; and of the lower extremity, the loss after secondary amputation was three times as great as after primary. During the seige of Sebastopol, among 80,000 wounded Russians there were 3000 amputations. Of the primary amputations of the upper extremity, leg, and foot, about one-half, and of the lower and middle third of the thigh, about one-third recovered; but of all the secondary amputations more than two-thirds died. Primary amputation, therefore, should always when practicable, be performed in preference to secondary.

But how soon after the infliction of the injury should it be practised? It is the opinion of some Surgeons that there is often an interval between the infliction of the injury and the supervention of the shock to the system, in which the limb may more advantageously be removed. Should the depression of "shock" have come on, it then becomes a question whether immediate amputation should be practised, or the removal of the limb delayed until reaction sets in. On this point it is obviously difficult to lay down any very definite rule; but it may, I think, be stated generally as the result of the experience of the best army Surgeons, that, if the shock be not very intense, the limb may, under chloroform, be safely removed. Should the prostration be excessive, and there be reason to fear the possibility of internal injury, it will be wiser to delay operation. But if an unsuccessful attempt at the preservation of the limb be made, and if occasion for its subsequent removal should arise, the Surgeon must wait until suppuration has set in before he operates, the period of acute inflammatory action being allowed to pass by. The cases that most commonly require secondary amputation are those in which traumatic gangrene has set in; here the limb must always be removed without delay, in accordance with the principles laid down in speaking of this subject in reference to contused wounds. If profuse

hemorrhage from the wound occur, and do not admit of suppression by the ordinary means, secondary amputation may become necessary. So, also, when the bones do not unite, the patient being worn out by discharges and the irritation of necrosis and caries, and left with a wasted, shattered, and useless limb, its removal is the only means of saving life. The great mortality after secondary amputation in military practice is, in great measure, owing to the unfavorable hygienic conditions to which the wounded soldier is usually exposed from over-crowding and want of necessary appliances. He is thus rendered peculiarly liable to the occurrence of pyæmia, septicæmia, and hospital gangrene.

The nature and treatment of gun-shot injuries of special regions, as of the head, chest, and abdomen will be considered in the Chapters devoted to the description of Injuries of those parts.

CHAPTER XI.

POISONED WOUNDS.

A very important variety of wound is that in which a poison is introduced. The most serious poisoned wounds are those inflicted by the stings of insects, the bites of snakes or of rabid animals, and injuries received in dissection.

STINGS OF INSECTS.

Stings of Insects, as of bees, wasps, mosquitoes, gnats, &c., though painful, seldom produce any serious inconvenience; yet occasionally they may do so, and may even prove fatal, by inducing erysipelas in some unhealthy constitutions, or by giving rise to intense irritation from the multiplicity of the stings, as when bees in great numbers swarm upon and sting a person; or they may be dangerous in consequence of the nature of the part that is stung, as the eye, or the interior of the mouth, or pharynx, as has happened from swallowing a bee in a piece of honeycomb. Mosquito-bites are peculiarly irritating, and when numerous poison the blood, producing nervous depression and great febrile irritation. The venom of a mosquito is very powerful, weight for weight probably more so than that of the rattle-snake. The bites of some insects, as scorpions, or the tarantula in Italy, give rise to more serious and even fatal disturbance. A peculiar train of nervous phenomena is said to follow the bite of the tarantula, hence called "tarantismus;" a disease that is generally stated to be peculiarly influenced by music, though this has been denied by Guzzo.

Treatment.—In the treatment of stings of insects the application of cooling lotions, of a cold poultice, or rubbing the part with olive-oil, will be found the most useful means of allaying irritation. In some cases, more especially in mosquito-bites, touching the part stung with strong liquor ammoniæ or potassæ gives relief, if applied at once. In the case of stings from wasps or bees, it should be ascertained that the sting has not been left in the wound. If so, it must be extracted, and the alkali applied.

SNAKE-BITES.

Snake-bites are seldom fatal in England; venomous reptiles, such as the viper and adder, not possessing a sufficiently energetic poison to destroy a healthy adult, though they might possibly kill a child or a very weak and delicate person. These reptiles are said to be most active in warm weather and during the season of procreation. Their bites are of course most dangerous if inflicted through a vein or glandular part, or near the centre of the circulation, or about the neck and face. In tropical countries the bite of the rattle-snake, of the cobra di capello, the puff-adder, or the tobacco-pipe snake, is often fatal. The number of persons who are annually killed by snake-bites in those parts of India alone from which returns are procurable amounts to about 12,000, or about 1 in every 5000 of the inhabitants; and it occasionally happens even in this country, that the Surgeon has an opportunity of seeing wounds inflicted by these fearful reptiles in menageries. Thus, Sir E. Home has recorded a fatal case of rattle-snake bite occurring in England. A similar instance has been seen at St. George's Hospital, and another in Paris, in showmen. The most remarkable case of this kind with which I am acquainted occurred some years ago at the University College Hospital, and afforded an opportunity, rare in this country, of witnessing the effects of the bite of a cobra di capello. The patient, a keeper at the Zoological Gardens, was bitten in the bridge of the nose, the poison-fang having apparently penetrated the angular vein. When brought to the hospital, about half an hour after the accident, he was apparently dying, being unable to speak, swallow, or support himself; the pupils were dilated, the face livid, the heart's action feeble, and he was scarcely conscious. After death, which took place in little more than an hour from the time of the infliction of the wound, the veins of the brain and the cerebral sinuses were found congested with blood, as were also the lungs to an immense extent, and the solid abdominal viscera. The right cavities of the heart were loaded with dark blood, the left being empty; indeed, the phenomena of asphyxia were strikingly marked. In this case, death would appear to have resulted from the poison paralysing the medulla oblongata, and those portions of the nervous system which are concerned in carrying on respiration, at the same time that the blood was disorganized by the action of the virus.

Effects of Snake-poison.—The venom of the cobra has been found to consist of an albuminous fluid of acid reaction, holding cells in suspension. When given internally, or applied to the conjunctiva, it fails to kill. Snake-poison, when introduced into the system through a bite or puncture, may prove injurious or kill, either by its primary and direct depressing influence on the nervous system, somewhat resembling that produced by some narcotic poisons; or, secondarily, and more remotely, by exciting severe diffuse inflammation of the areolar tissue of the limb or part. The intensity of its effects depends in some measure upon the vigor of the animal inflicting the wound; one that has been compelled to bite frequently has no longer the destructive power which it had when fresh.

The first mode of death occurs only when the poison is either very powerful, or the animal bitten small. Thus the poison of the tobacco-pipe snake is said to be so virulent, that it will kill a full-grown man in less than a quarter of an hour. The rattle-snake, and the cobra di capello, will kill a small animal in the course of a few seconds; and a man, bitten some years ago by a rattle-snake in Paris, died in nine

hours; the cobra bite just related was fatal in little more than one hour; and the Australian tiger-snake will kill in less than twenty-four hours.

When the snake is less venomous and death is not speedy, the poison excites diffuse inflammation and suppuration of the areolar tissue of the limb bitten. This is a very common consequence of the bite of the adder and the viper in this country. It may also occur after bites by the larger ophidia. Thus, in the case which occurred in St. George's Hospital, the patient died on the eighteenth day after the bite of a rattle-snake, with large abscesses in the arm and in the axilla, and with sloughing of the areolar tissue of the limb.

The SYMPTOMS occurring after a poisonous snake-bite consist in great depression and prostration of the system, a feeble and intermittent pulse, dilated pupils, usually slight delirium, indistinctness of speech, at times complete aphasia, speedy stupor, insensibility, and death. The pain is burning and lancinating, whilst the part bitten swells and becomes livid in a few hours; and if the patient survive sufficiently long, diffuse inflammation and gangrene occur in its neighborhood; involuntary actions take place; asthenic symptoms set in, which may eventually terminate fatally, or end slowly, and after a lapse of time, in the recovery of the patient, whose health may long suffer seriously from the effects of the accident.

TREATMENT.—This is local and general.

The **Local Treatment** can only be fulfilled with success when the patient is seen immediately after the accident, as the absorption of the poison is very rapid. It presents two great indications: 1, to prevent the absorption of the poison into the system; and 2, to treat the diffuse inflammation and sloughing that may subsequently occur. The first indication may be fulfilled by tying a ligature so tightly round the limb at a little distance above the injured part, as to arrest all circulation through it. In this way the absorption of the poison may be prevented; the wound should then be freely cauterised with a red-hot iron or cinder, or better still, excised, and a cupping-glass applied over the cut surface, so as to withdraw the blood in the neighborhood which may have become contaminated by the poison. If a cupping-glass be not at hand, or if the part bitten be so situated as not to admit of its application, there can be no objection to the employment of suction by the mouth after free excision; the poison not being absorbed by an unbroken mucous membrane. In using suction, the mouth should be rinsed with brandy. With the view of lessening the swelling, tension, and pain of the limb, frictions with olive oil are said to be advantageous. After diffuse inflammation has set in, this must be treated on general principles—by fomentation and free incision.

The **Constitutional Treatment** consists in the early and free administration of the most powerful stimulants, with the view of combating the depression that exists. For this purpose, brandy, wine, ammonia, or ether must be freely given. The *eau de luce*—which enjoys a high reputation in some tropical countries—owes its efficacy to the ammonia which it contains. Should drowsiness come on, the patient must be made to walk about; and artificial respiration with galvanism may be resorted to as a last means of maintaining life until the effects of the stimulants may overcome those of the poison. Enforced exercise—the patient being made to run for some distance behind a carriage driven at a steady pace—is another means of keeping up the respiration, while the sweating aids in the elimination of the poison. Large doses of arsenic

have been recommended as a kind of specific, and the "Tanjore pill," a celebrated Indian remedy, owes its activity to this mineral; but care must, of course, be taken in administering this, lest the remedy prove as fatal as the injury for which it is administered. Halford, of Melbourne, has used, in cases of bite by the "brown snake," a very venomous kind, whose bite is nearly always fatal, an injection of strong solution of ammonia, diluted with twice its bulk of water, into a superficial vein, such as the radial. Fifteen or thirty minims are thrown in, and repeated according to circumstances. The effect is described to be an immediate rousing of the patient from his stupor. Sir Joseph Fayrer, however, finds that this remedy has no power in cases of cobra bite, or as an antidote to the poison of Indian serpents, whatever its efficacy may be in counteracting the deadly effects of those of the Australian species. As liquor potassæ decomposes the virus into a sediment and supernatant fluid, both of which are innocuous, it might be supposed that it would act as a true antidote, but it has not been found to do so when injected into the blood of bitten animals.

The difficulty with respect to antidotes for snake-poisoning appears to consist in the application rather than in the possibility of the discovery of one. The venom of a snake is at once injected into the blood of the animal bitten, is carried with the circulation to the nervous centre, decomposing the fluid that conveys it, so that it has the start of any antidote that can possibly be applied in a sufficient time to prevent its direct toxic effects on the system. It is difficult to understand how an antidote could act unless it were injected into the veins simultaneously with the introduction of the snake-poison into the blood. Unless a surgeon be at hand prepared to do this at the moment, as in the case of an animal bitten for experiment, too much time would be lost to render the counteraction of poison possible. And it is evident that drugs or substances swallowed with the view of acting as antidotes could not be absorbed from the stomach in time to be efficacious.

BITES OF RABID ANIMALS: HYDROPHOBIA.

Bites of rabid animals give rise to the disease so much and so justly dreaded, but fortunately seldom seen in man in this country, **Hydrophobia**.

This disease cannot originate *de novo* in man, but invariably occurs in him, and most commonly in the lower animals, as the result of inoculation. Animals of the canine and feline species are most subject to it; especially the dog, the wolf, the fox, the jackal, and the cat. It has not, I believe, been observed in lions or tigers, or in the larger feline animals. Does rabies ever originate *de novo* in animals? Most veterinary surgeons are of opinion that it does not, but is invariably the result of contagion. If ever it do arise spontaneously, its causes are very obscure. But it certainly appears to be subject to epidemic variations. In some years hydrophobia is never heard of—in others it is very rife. Hydrophobia has followed the bite of an animal that has shown no signs of rabies—one of those many inexplicable occurrences in this singular disease. It has been attributed to the influence of season, being most common in the early spring months; thus Eckel found it most common in dogs in February and May. Want of water, sudden changes from heat to cold, bad food, and unsatisfied sexual desire, have also each been assigned as causes of its occurrence in animals. When we inquire into the operation of these alleged causes, we fail to discover any direct and positive

connection between any one of them and rabies. With regard to the influence of heat and want of water, it would appear that in those countries in which animals of the canine and feline races are most exposed to these conditions, hydrophobia is unknown. Thus Mr. Donovan, who has resided and travelled for many years in Central Africa, informs me that, in the deserts of that country, where water is so scarce that man and beast often die of thirst, lions are always to be found and are occasionally seen going about in families, whilst hyenas, jackals, and wild dogs are most numerous, and yet hydrophobia is unknown. Barrow, a scientific and observant traveller, makes a similar statement, viz., that hydrophobia cannot proceed from thirst and heat, as it is unknown in Egypt, the West India Islands, and some other tropical parts. The theory of hydrophobia arising from ungratified sexual desire appears to be equally untenable. It is not uncommon in Africa, Mr. Donovan says, for wolves, jackals, and wild dogs to prowl about mad with heat; and in this state they are most dangerous, so much so that domesticated dogs instinctively shun them, but there is no evidence of their ever having communicated hydrophobia. Having been told that no bitches were allowed in Sark, I wrote to Dr. Cockridge of that Island to inquire if this were the fact, and if so, whether hydrophobia were prevalent there. He informed me that there were no bitches in the island, and that dogs were very numerous, but that no case of hydrophobia had, to his knowledge, ever occurred there, and that the clergyman, who had had thirty years' experience of the island, had never heard of a case of that disease. Dogs more frequently become rabid than bitches; thus, of a hundred and forty-one cases collected by Eckel, only fifteen occurred in bitches; and amongst dogs it is most common in those of a mongrel breed, seldom effecting those that are of pure blood, or that have been castrated.

In man, hydrophobia occurs either from the bite of a dog known to be rabid, or by the hand or face of the master whilst caressing the animal being bitten, or from a raw surface, as a crack in the lip, being licked by an animal ill of rabies, but in whom the characteristic symptoms have not developed themselves. But it is important to know that the bite of a rabid animal is by no means certain to occasion hydrophobia. In fact, the vast majority of people who are bitten by animals in a state of rabies do not take the disease. Thus Hunter and Vaughan (Halford) state that only one out of twenty or thirty who are bitten by rabid dogs becomes hydrophobic. But the bite of a rabid wolf is far more dangerous than that of a mad dog. Watson states that of 114 persons bitten by rabid wolves, 67 died of hydrophobia. The bite of a rabid cat is also more dangerous than that of a dog. The fact is that the dog usually bites at the legs, and thus when he inflicts a wound, it is through clothing by which his teeth are wiped and the saliva arrested, and thus the wound escapes inoculation. Wolves and cats, on the other hand, always fly at naked parts of the body, as the face or throat; hence the greater danger of their bites. But making all allowance for the mechanical action of clothing in preventing inoculation of the part bitten, there is, I think, good reason to believe that there is great difference in the susceptibility of different individuals to the poison of rabies. For it is an undoubted fact that veterinary Surgeons and others have often been bitten in an uncovered hand by rabid dogs, and yet have escaped the disease. Elliotson mentions the cases of two sisters who were both bitten in the face by the same rabid dog. The first escaped—the second died of

hydrophobia. White, of Brighton, disbelieving in the contagion of the disease, inoculated himself with the saliva of a rabid dog with impunity.

There is this important difference between the poisonous impregnation of the wound by the bite of a rabid dog and of a snake. In the case of the dog the poison is only adherent to the tooth, and hence, if this be wiped in its passage through clothing, the bite is rendered innocuous. In the case of the snake, the poison is projected through the hollow fang, and hence, wherever that enters, however cleanly its exterior may be wiped, this drop of poison is injected into the parts at the extreme point of penetration. A snake that bites through a gaiter or glove, would, therefore, inflict as deadly a wound as if the unprotected foot or hand were struck by the fang; whereas the tooth of the rabid dog would be wiped, and the bite be harmless.

The period that intervenes between the bite and the occurrence of the disease is usually considerable. Meade has related the case of a lady who had the disease fifteen months after the bite; and Mayer of St. Petersburgh that of a young man who died of hydrophobia twenty-six months after being bitten. Elliotson says that the average time that elapses between the injury and the symptoms is from six weeks to three months. In the case of the Duke of Richmond, who was bitten by a tame fox, the disease did not develop itself until between six and seven weeks after the injury. Writers, however, in stating that six, seven, twelve, and even fifteen years have intervened between the infliction and the wound and the manifestation of the symptoms, have evidently committed an exaggeration or fallen into error, having probably confounded with hydrophobia other nervous affections that closely resemble it.

Symptoms.—The wound has generally cicatrised long before any symptoms of hydrophobia declare themselves; and no peculiar appearance is presented by the scar. Shooting pains, twitching and itching sensations have, however, occasionally been experienced in the site of the wound before the supervention of the attack; and it is probable that in all cases some process analogous to a zymotic action takes place within it before the disease comes on. The precise nature of this requires to be elucidated by further observation.

The symptoms are usually ushered in for two or three days (according to Perry for five or six) by some antecedent phenomena, consisting of giddiness, chills, and heats, and a general feeling of discomfort. In some cases vesicles under the tongue have been observed. The more *special* symptoms never manifest themselves until the disease is fairly established; they consist essentially in violent and repeated convulsive movements of a reflex character, induced by various external influences acting on the surface of the body or on the fauces, or by mental impressions; and they speedily end in exhaustion and death. The special symptoms consist of: 1, Spasmodic Affection of the muscles of Deglutition and Respiration; 2, Extreme Sensibility of the Surface and of the Senses; and 3, Excessive Mental Terror and Agitation.

1. In consequence of the **Spasmodic Affection of the Muscles of Deglutition**, the act of swallowing commonly excites convulsions; hence the patient experiences a horror of all liquids; and, in attempting to drink, gulps down the fluid with a strong mental effort. In some cases, solids give rise to the same difficulty in deglutition as liquids; but occasionally, though rarely, patients have been known to swallow perfectly well throughout the disease. This difficulty in swallowing is certainly owing to an excessive sensibility about the pharynx and throat, in consequence of which every effort at deglutition induces violent reflex

convulsive movements in all the muscles and parts supplied by the pneumogastric nerve.

A catch in the breathing, resembling what often occurs when a person goes into a cold bath, is met with as one of the earlier symptoms, taking place in the midst of conversation, and before the patient's mind is directed to the nature of the disease. This catch is due to the spasmodic descent of the diaphragm, and gives rise to severe pain at the pit of the stomach, or to a feeling of suffocation and a return of the convulsions. In consequence of this spasm of the diaphragm, the patient makes from time to time a loud hiccuping noise, which has been likened to the bark of a dog.

2 Excessive **Sensibility of the Cutaneous Nerves, and of some of the Nerves of Special Sense,** is characteristic of hydrophobia. The cutaneous nerves become so sensitive that a blast of cold air, the rustling of the bed-clothes, the slightest touch of or movement on the skin, will bring on convulsions. The nerves of sense become equally excitable, so that a sudden flash of light before the eyes, as the reflection of the sun from a looking-glass, or a sudden noise, as the slamming of a door, will produce the same effect. The noise produced by liquids being poured from one vessel to another is peculiarly distressing to the patient; and Elliotson mentions a case in which a patient with hydrophobia was thrown into violent agitation by hearing the dresser who sat up with him void urine. The sufferings and convulsions that patients experience when they attempt to drink, appear to be owing to excessive sensibility of the nerves of the mouth and pharynx, and the recollection of these sufferings makes them afraid to repeat the attempt; hence the fear of liquids from which the disease derives its name.

3. One of the earliest symptoms, and one of the most persistent, is extreme **Mental Agitation and Terror,** a vague sense of dread and horror at the impending fate. Spectral illusions sometimes occur, the patient supposing himself to be surrounded by animals, by horrid forms, or by gaping, ghastly, and grinning countenances, by flies or wasps. The first symptom in the Duke of Richmond's case, was that he fancied some poplar-trees opposite his bedroom window to be men looking in. These delusions may alternate with fits of delirium, terror, and frenzy. In these it is said that the patient barks like a dog, and endeavors to bite; but this is a popular error—the pretended bark is merely the catch in breathing, and the attempt to bite is nothing but movements of the tongue and mouth induced by the viscid and ropy saliva.

Occasionally the symptoms subside completely before death; the increased sensibility of the surface disappearing, the mental agitation or delusion being removed, and deglutition and respiration being quietly performed. Thus, Latham relates the case of a man laboring under this disease, who sat up quietly in bed and drank a pint of porter half an hour before he died.

The Surgeon is sometimes asked to give an opinion as to the condition of a dog that has bitten a person, and which is suspected of being mad. The following description of the symptoms of **Rabies in the Dog,** by Dr. Burdon Sanderson, will aid him in coming to a conclusión on these points.

"The premonitory indications of rabies in a dog are derived almost entirely from the observation of changes in its demeanor; consequently, although they may be too trifling to be noticed by a casual observer, they are fortunately sufficiently striking to arrest the attention of any

one who is about a dog, and is familiar with its habits and individual peculiarities.

"A dog about to become rabid loses its natural liveliness. It mopes about as if preoccupied or apprehensive, and seeks to withdraw into dark corners. From the first there is usually a foreshadowing of that most constant symptom of the disease—depraved appetite. Mad dogs not only devour filth and rubbish of every kind with avidity, but even their own excrement—often immediately after it has been passed. Indications of this tendency appear early, and are more than suspicious.

"Along with this peculiarity of behavior it is of equal importance to notice that an infected dog, from the first, snaps at other dogs without provocation. This snappishness in most dogs is very striking. If a dog previously known to have no such habit, snaps indiscriminately at the first dog it meets in the yard or in the street, it is probably not safe.

"So far I have had in mind chiefly what is to be observed in dogs tied up or at home. A dog which is at large is also to be recognised as in a dangerous state by its demeanor. A healthy dog in its progress along a street or elsewhere shows at every step that its attention is awake to the sights and sounds which it encounters. The rabid dog, on the contrary, goes sullenly and unobservantly forwards, and is not diverted by objects obviously likely to attract it. This statement, however, is subject to the important exception already referred to, that it is excited both by the sight and sound of an animal of its own species.

"Of the symptoms which accompany the final stage of the disease, the most important and characteristic are those which relate to the organs in which it localises itself—the mouth and throat. Attention is often drawn to the condition of the mouth in an animal supposed to be healthy, by the observation that it tries to scratch the corners of its mouth, as if attempting to get rid of the ropy mucus which is seen to be discharged from it. In dogs that are tied up, it is noticeable that the bark has entirely lost its ring, and acquires a peculiar hoarseness, which can be recognised even by the most unobservant. As the disease progresses the discharge increases, the lower jaw hangs as if paralysed, and the animal has evident difficult in swallowing. Along with this there is often loss of power of the hind limbs. If now the dog be watched, the peculiarities of behavior which have been already noticed are seen to present themselves in a much more marked degree than before. It is observed, first, that it is subject to paroxysms of excitement, in which it makes often-repeated efforts to bite or gnaw all objects (such as woodwork, straw, &c.) within its reach, while at the same time it continues to exhibit the tendency already mentioned to devour its own excrement; and, secondly, even during the remissions its excitement is at once renewed by the sight or sound of another dog

"It may be well to note that the disease occurs at all seasons, that the mad dog continues to recognize its master and to manifest pleasure when kindly spoken to, that it does not shun water, and that in many cases from first to last that wild fury which is commonly supposed to belong to the disease, is conspicuously absent."

Prognosis.—I am not acquainted with any case of recovery from hydrophobia, after the disease has fairly set in. It cannot, however, be pronounced to be absolutely and inevitably fatal; for Radcliffe states that, of 109 authentic cases, recovery took place in 14. The disease may prove fatal in four-and-twenty hours, or life may be prolonged for six or seven days; death generally occurring from the second to the fourth day apparently from exhaustion.

Pathology.—The appearances found after death throw no light whatever upon the disease, and indeed may often be supposed to be simply the effects of the spasmodic irritation. The tongue, the fauces, the throat, the glottis, and the larynx, the stomach and œsophagus, the brain, the medulla oblongata, and spinal cord, have all been found congested and inflamed; there is nothing, however, in the appearances presentad by these parts that affords a clue to the true nature of this inscrutable and terrible malady. In fact, everything connected with hydrophobia is at present involved in complete obscurity. We neither know what occasions rabies in the dog, nor in what consists the change in his secretions that enables him to transmit the disease to man. Equally obscure are the processes that are going on at the seat of the wound or in the constitution generally, during the period that intervenes between the infliction of the bite and the development of the disease; and lastly, pathological research has hitherto failed to throw the faintest glimmer of light on the nature of the changes which the nervous system undergoes, and which occasion the characteristic phenomena of hydrophobia.

Treatment.—This must be principally *preventive* and *palliative*. We cannot speak of *curative* treatment of hydrophobia; for, after the disease has once set in, the utmost that can be done will not accomplish more than to lessen the patient's sufferings, and stay for a few hours the inevitably fatal termination.

When a person is bitten by a rabid dog, or even by one that is reasonably supposed to be so, the Surgeon should always adopt energetic means to save the patient from the invasion of a disease that is necessarily fatal. In having recourse to preventive treatment, it should be borne in mind that the larger proportion of persons actually bitten by rabid animals do not fall victims by hydrophobia; the probability of the occurrence of the disease depending partly upon the animal that bites, and partly upon whether the bite is inflicted on the naked or on the clothed part of the body, and possibly also on individual susceptibility to the disease as has already been stated. It is in consequence of this small proportion of persons taking the disease out of the total number bitten, that so many popular remedies and superstitions have obtained an unmerited reputation for preventing the disease. The only preventive means that can be trusted to by a Surgeon, are *excision* and *caustic*.

Excision of the part bitten should be carefully and freely performed, no half measures being had recourse to. Hence it is better to remove too much of a comparatively unimportant tissue or part, than to allow the sufferer to run any risk or falling a victim to the fatal disease. In order to excise every part that has been touched by the tooth, the Surgeon, after washing the wound and contiguous surface with strong carbolic acid lotion, should make a circle with ink, or tincture of iodine, completely around the injured part. He must then pass a probe to the bottom of the wound, and excise the whole by scooping out a conical piece of the tissues, taking care to go beyond the furthest limit to which the probe is passed. If there be any doubt of the removal of the whole of the injured parts, potassa fusa should be applied. If the lip be bitten through, a portion should be cut out, and the wound brought together, as in hare-lip operations; if a finger be injured, it should be amputated. When the wound is so situated that excision cannot readily be performed, potassa fusa, or strong nitric acid, or nitrate of silver, as recommended by Youatt, should be freely applied to every corner of it. If the wound have already cicatrised, the bitten part should be excised at any time after the injury, provided the dog is known to have been mad, or to

have become so afterwards; for it is not improbable that, in the cases where the disease has occurred at a remote period, it has been dependent upon, or connected with, some peculiar action set up in the wound, which might possibly be averted by the removal of the cicatrix.

I forbear to speak of any other means of constitutional preventive treatment, as I consider them utterly undeserving of confidence.

After the disease has once set in, nothing can be done but to *palliate symptoms* and to prolong life. Every possible remedy that the ingenuity of man could devise, from warm water to viper- and ticuna-poison, has been tried, and been found utterly useless. The only plan of treatment that holds out a hope of eventual success, and which, whether it succeed or not in curing the patient, at all events mitigates his sufferings, is that which has been recommended by Marshall Hall and Todd. It consists in the first place, in removing all external irritation, whether mental or bodily; putting the patient in a darkened room, as much removed as possible from all noise and the intrusive curiosity of strangers, and surrounding his bed with gauze curtains or screens, so as to prevent the disturbing influence even of a draught of cold air. Measures must then be adopted to lessen the excitability of the spinal cord: this may be done efficiently, as Todd suggests, by the application of ice in a piece of gut laid along the whole length of the spine, or by means of a spinal ice-bag. Lastly, the Surgeon must bear in mind that he has to treat an exhausting disease, and that he must consequently support the patient by wine, beef-tea, and such nourishment as can be taken.

WOUNDS WITH INOCULATION OF DECOMPOSING ANIMAL MATTER.[1]

The majority of wounds of this character are not dangerous. Every student of anatomy frequently punctures and cuts himself in dissecting, but we rarely see any ill effects from these injuries. In some cases, however, the most serious results, terminating in permanently impaired health, or even in death, ensue. The result depends quite as much on the state of health of the person injured, as on the condition of the body from which the poison is received. If the health be broken by any cause, whether excess of study or dissipation, or over-fatigue in professional work, very serious effects may follow, which would not occur if the patient had the resisting power of a sound and strong constitution.

CAUSES.—The deleterious influence exercised by the dead body, human or brute, may be attributed to three different causes:—1, the ordinary Irritation of the Wound; 2, Inoculation of Putrid Matter; or, 3, Introduction of a Specific Septic Virus into the system. I think it probable that each of these causes may exercise a distinct influence, but that the worst effects of dissection-wounds are dependent on the inoculation of a peculiar and specific virus.

1. That ill effects sometimes result from the simple **Irritation of the Puncture**, is evident from the fact that mere scratches or punctures with splinters of wood, or other substances free from an actual poison, give rise to considerable local disturbance in certain states of the constitution: so also those operation and dissection-wounds which are ragged and torn, such as are made by spicula of bone or the teeth of a saw, are peculiarly troublesome.

2. **Putrescent Matters** are always injurious when introduced into the animal economy; but at the same time it is a remarkable fact, that the worst effects of dissection-wounds have resulted from those received

[1] See also Chapter XXXI—Septicæmia.

before putrefaction had set in, and that the most dangerous wounds more commonly occur in *post-mortem* inspections made a few hours after death, than in dissecting-room investigations on parts in an advanced stage of decomposition.

3. That the worst forms of dissection-wounds are dependent upon a **Specific Septic Virus**, is evident from the fact that it is especially after death from certain diseases, particularly those of an erysipelatous or pyæmic type, that these consequences ensue. Most danger is to be apprehended from punctures received from the bodies of those who die of erysipelas, phlebitis, pyæmia, and the diffuse forms of peritonitis following parturition or the operation for hernia. And it is very important to remember that putrefaction is by no means necessary for this. The greatest danger exists before putrefaction sets in. A few hours after death, whilst apparently still quite fresh, the body is in the highest degree infectious and dangerous; and I think that advanced putrefaction rather lessens than increases the danger. Indeed, the septic influence in these cases continues after death to be capable of producing in the living who are inoculated with it, a distinct affection of the nature of septæmia. Of all these influences, that which is generated by hernial or puerperal peritonitis is by far the most noxious. The acrid fluid which accumulates in the peritoneum when that structure is attacked by diffuse inflammation of the kinds just mentioned, appears to exercise a specifically injurious influence. I believe it to be impossible to immerse the hand into it with impunity if there should happen to be a scratch, puncture, or abraded surface of any kind on one of the fingers. Inoculation would, under such circumstances, inevitably ensue, followed by diffuse inflammation to a greater or less extent. It is, however, by no means necessary for *post-mortem* infection, that there be an abraded or broken surface through which the inoculated matter may be introduced into the system. Imbibition may take place through the unbroken cuticle; and not unfrequently it is through the medium of the hair-follicles that the septic poison enters. In the graphic account given by Sir James Paget of his own case, the septic influence is stated to have been absorbed through the unbroken cuticle of the hand immersed in pyæmic pleuritic effusion. I have known poisoning through the hair-follicles of the back of the hand to happen to another very distinguished member of our profession. In other cases, again, infection appears to have taken place by absorption under the semilunar fold of skin at the base of the nail. That the poisonous influence from the bodies of persons who have died of septic diseases is transmissible to others by contact or infection, cannot be denied; and accoucheurs and operating Surgeons should abstain as carefully as possible from performing *post-mortem* examinations on patients dying from such diseases, lest the poisonous influence be carried to and excite similar morbid action in their own patients.

Symptoms.—From what has been stated above, it would appear that there are two distinct kinds of mischief resulting from dissection-wounds.

The *milder form* proceeds from the simple irritation of a scratch in a broken constitution, or from the inoculation of non-specific putrescent matter. The punctured part becomes painful, hot, and throbbing, in from twelve to twenty-four hours after the injury; the finger swells and inflames, the absorbents of the arm are perhaps affected, and the glands in the axilla become enlarged. There is general febrile disturbance, ushered in by rigors and a feeling of depression and often intense headache; suppuration takes place about the puncture, and also, perhaps, in

the inflamed glands, the case presenting the ordinary characters of whitlow with inflammation of the absorbents.

In the *more severe form* of dissection wound, the patient is seized about twelve or eighteen hours after the puncture, with rigors, anxiety of countenance, and depression of the nervous system; with a quick pulse, and with inflammatory febrile reaction. On examining the finger, a pustule, or vesicle, with an inflamed areola, will be observed in the situation of the puncture; from this a few red lines may be seen extending up towards the arm-pit, where there may be swelling and tension. Diffuse inflammation of the areolar tissue of the limb sets in about the fifth or sixth day, extending up to the shoulder, and down the side of the chest to the flank. Abscesses form, often with much pain, in these situations; they are usually somewhat diffuse, the pus being mixed with shreds and sloughs. The general symptoms gradually assume an asthenic type; the tongue becomes brown, sordes accumulate about the lips and gums, low delirium sets in with a rapid feeble pulse, and death occurs in from ten days to three weeks. When incisions are made into the brawny tissue it is found infiltrated with sero pus, and in a sloughy state. If the patient live, large circumscribed abscesses form under the pectoral muscles, in the axilla, and above the clavicle, accompanied by much exhaustion and depression of the system. The convalescence is tedious and prolonged, and the constitution is often shattered for life.

It is this form of the disease that resembles diffuse inflammation of the areolar tissue arising from other causes; and indeed there can be little doubt that it is a cellular erysipelas depending on toxic agency. That this form of dissection-wound is of a truly specific character, is evident from the fact that patients laboring under it may communicate fatal erysipelas to their nurses and attendants; as happened in the case of the late J. P. Potter, of University College Hospital, whose early death was much to be lamented. It is also this kind of dissection-wound that is especially apt to occur after punctures, received from patients who have died of diffuse inflammation of the serous membranes.

The symptoms produced by contact, independently of any wound, with the bodies of persons who have died of erysipelatous or pyæmic diseases, sometimes vary, though still referable to the introduction of a poison. Thus I have known a body to infect seriously in different ways six students who were working at it. Two had suppuration of the areolar tissue, under the pectorals and in the axilla; one was seized with a kind of maniacal delerium; a fourth had typhoid fever; and the remaining two were seriously, though not dangerously, indisposed.

Treatment.—On the receipt of a puncture in dissection, or in making a *post-mortem* examination, the best mode to prevent injurious consequences is to tie a string tightly round the finger above the injury, thus causing the blood to flow, and perhaps to carry out the virus with it. The part should then be well washed in a stream of cold water at a tap, and sucked for some minutes; in this way any poisonous matter that has been introduced may usually be got rid of. It is better not to apply caustics: they only irritate and inflame the finger, and can do but little good. If any caustic be employed, it should be a drop of nitric acid let fall into the wound, or of pure carbolic acid, which is the only escharotic that has the power of destroying animal virus. The nitrate of silver, which is commonly employed, can never do much good, as it does not penetrate to a sufficient depth to be of service. Dissectors should bear in mind that the state of the constitution exercises great influence upon the effects of the puncture; and that, in proportion as the health is sound

and the body not exhausted by over-fatigue, there is less likelihood of any injurious consequences ensuing.

In the slighter forms of dissection-wound, attended by a moderate amount of inflammation, the part must be poulticed, leeches should be applied, and the arm put in a sling. If the absorbents become inflamed, chamomile and poppy fomentations must be diligently used, abscesses must be opened early, and free incisions should be made wherever there is much tension, even though matter have not already formed, with a view to prevent suppuration. The general treatment of clearing out the bowels with a free calomel purge, followed by moderate stimulation, must be adopted in the early stage; but tonics and strong support will soon be required, and, if there be much constitutional irritation, opiates may advantageously be administered.

The treatment of the more severe forms of dissection-injury consists principally in fomentations, and in early and very free incisions into the finger or other parts that become tense and brawny. In the constitutional treatment, our great reliance, after clearing out the intestinal canal by a free purge, consists in the administration of bark, ammonia, camphor, wine and brandy, with such fluid nourishment as the patient can take; the case being treated as one of the lowest forms of asthenic inflammation. If the patient survive he must be sent as soon as possible into the country, and must devote some months, perhaps, to the re-establishment of his health. The punctured part often continues irritable for a great length of time, even for many years, remaining red, inflamed, and desquamating, pustules sometimes appearing on it. This condition is best remedied by the occasional application of nitrate of silver.

In conclusion, I cannot too strongly urge upon the dissecting student that unless he take scrupulous precautions as to cleanliness and disinfection, he may readily contaminate with septic poison any patient whose wound he dresses. No dissecting student or operating surgeon who has examined a dead body ought to approach a patient without having previously changed his woollen clothes, and, after washing, soaked his hands in carbolised water, or otherwise disinfected himself.

CHAPTER XII.

EFFECTS OF HEAT AND COLD.

BURNS AND SCALDS.

A **Burn** is the result of the application of so great a degree of heat to the body as to produce either inflammation of the part to which it is applied, or charring and complete disorganization of its tissue. A **Scald** is occasioned by the application of some hot fluid to the body, giving rise to the same destructive effects as are met with in burns, though differing from them in the appearances produced.

Local Effects.—Burns and scalds vary greatly in the degree of disorganisation of tissue to which they give rise; this variation depending partly upon the intensity of the heat, and partly upon the duration of its application. The sudden and brief application of flame to the surface

produces but very slight disorganisation of the cuticle, with some hyperæmia of the skin. If the part be exposed for a longer time to the action of the flame, as when a woman's clothes take fire, the cutis itself may be disorganised; and if the heat be still more intense, as when molten metal falls upon the body, the soft parts may be deeply charred, or the whole thickness of a limb destroyed. So, also, the effects of scalds vary greatly, not only according to the temperature of the liquid, but according to its character; the more oleaginous and thick the fluid, the more severe usually will the scald be.

These various results of the application of heat to the surface have been arranged by Dupuytren into six different degrees of burn. This classification is not merely a fanciful, or even a purely pathological, arrangement of the effects produced by the application of heat; but it is of great practical importance, as the degree and character of the resulting cicatrix are dependent on the depth to which the burn penetrates into the tissues. Hence the future conditions can be determined by ascertaining, in the first instance, the degree to which the burn belongs.

In the *first degree*, the application of fire has been momentary. It has been followed by congestive redness and pain—phenomena that resemble erysipelas. But there is no solution of continuity, no destruction of tissue; and consequently there is no resulting cicatrix. This is the acute stage of the first degree. In other cases, the effects may be more chronic, as in those instances where, in old people who sit constantly before the fire or over charcoal foot-warmers, changes are gradually induced in the integuments and superficial structures of the lower extremities.

In the *second degree* the cuticle is detached; and there are vesications and phlyctenæ. There is consequently loss of substance, so far as cuticle is concerned. This is sometimes followed by suppuration; and, although no cicatrix results in these cases, yet discoloration of the integument is often left.

In the *third degree* the whole of the cuticle is destroyed, with a portion of the true skin; but the *cutis vera* is not entirely destroyed. This is a most important point, as it influences materially the character of the resulting cicatrix. As a thin layer of true skin is left at the bottom of the eschar, complete reproduction of the whole thickness of the integumental structures is not necessary. In these cases there is a vivid red granulating surface, which suppurates abundantly. As the action of the burn extends to unequal depths, the granulations will be very irregular, and unless great care be taken, the resulting cicatrix will present corresponding elevations and depressions.

In the *fourth degree* there is complete destruction of the skin through its whole thickness, so that the subcutaneous areolar tissue is opened up. The process of cicatrisation in these cases may take place either by the growing together of the opposite sides of the wounds that results from the separation of the eschars, or by the formation of a thick and highly contractile cicatrix of entirely new formation. The process of repair in these cases is very slow, and is attended by long-continued suppuration. The resulting cicatrix is at first thin, red or purplish, glazed, often in the form of bands or bridles, and is liable to occasion great deformity by the cohesion of parts, as of the fingers, or by contraction, as at the elbow, or at the side of the neck and face, or by the closure of apertures, as of the nostrils.

In the *fifth and sixth degrees* the destructive influence of the burn penetrates to a greater or less depth into the muscles, bones, or joints.

In the fifth degree, the more superficial muscular structures are implicated: in the sixth degree the whole thickness of the limb may be destroyed and charred.

This is very briefly the celebrated classification introduced by Dupuytren, and adopted by most writers on the subject as a practical exposition of the local effect of burns. These various degrees are usually found associated to a greater or less extent; indeed, in the more severe cases, the first three or four degrees are almost invariably met with together.

Surgically, the fourth degree is the most important, and most severe burns extend to it. Its importance is due to the complete destruction of the whole thickness of the skin, and the consequent extensive granulating and suppurating surfaces that are left; and to the tendency to deformity from the contraction of the cicatrices, formed as they are of entirely new tissue, the great peculiarity and tendency of which is to contract into hard bands and bridles.

The primary *local effect*, then, of a burn, if superficial, is to excite inflammation of the skin; if more extensive, to destroy more or less the soft structures, and even the bones. When the cuticle is unbroken, the inflammation speedily subsides with some desquamation. When the soft parts are charred, they are detached by a process of ulceration, analogous to what happens in the separation of sloughs; and an ulcerating and suppurating surface is left, remarkable for the large size, the florid color, the great vascularity, and the rapid growth of its granulations. The cicatrisation of such an ulcer, though generally proceeding with great rapidity, has a constant tendency to be arrested by the exuberance of the granulations. The cicatrix is usually thin, and of a bluish-red color, and is especially characterised by a great disposition to contract, becoming, after a time, puckered up, and much indurated. This process of contraction and hardening, which begins immediately on the completion of cicatrisation, continues for many months, giving rise frequently to the most distressing deformit es, and to the complete loss of motion and use in parts. These cicatrices are fibro-plastic, and often extend deeply between and mat together the muscles, vessels, and soft structures of a limb, of the face, or of the neck.

The CONSTITUTIONAL EFFECTS resulting from burn are most serious and important; they depend not so much upon the depth of the injury as upon its situation, the extent of surface implicated, and the age of the patient. Thus a person may have his foot completely charred and burned off by a stream of molten iron running over it, with far less constitutional disturbance and danger than if the surface of the trunk and face be extensively scorched to the first and second degrees; burns about the chest, the head, and the face, being far more likely to be attended by serious constitutional mischief than similar injuries of the extremities. In children, the system generally suffers more severely from burns than in adults. The fever that sets in may be due to several causes, such as reaction after extreme primary depression, local inflammatory lesions, and the retention in the blood of waste products in consequence of the arrest of the cutaneous secretion in the burnt parts.

The constitutional disturbance induced by burns, in whatever degree, may be divided into three stages: 1, Depression and Congestion; 2, Reaction and Inflammation; 3, Suppuration and Exhaustion.

1. The stage of **Depression of the Nervous System and Congestion of Internal Organs,** occupies the first forty-eight hours; during which, death may occur before inflammatory action can come

on. Immediately on the receipt of a severe burn the patient becomes cold and collapsed, and is seized with fits of shivering, which continue for a considerable time. He is evidently suffering from the shock of the injury; the severity of the shivering is usually indicative of the extent of the constitutional disturbance, and is more prolonged in those injuries that occupy a great extent of surface, even though it be only burnt to the first or second degree, than in those which, being of more limited superficial extent, affect the tissues deeply. On the subsidence of the symptoms of depression, there is usually a period of quiescence before reaction comes on; and during this period the patient, especially if a child, not unfrequently dies comatose; death resulting from congestion of the brain and its membranes, with, perhaps, serous effusion into the ventricles or the arachnoid. Besides these lesions, the mucous membrane of the stomach and intestines, as well as the substance of the lungs, is usually found congested.

The pathological phenomena of this period are altogether of a congestive character. Of 15 cases in which the contents of the cranium were examined. I found congestion of the brain and its membranes, with serous effusion, in all; in 14 of these cases the thoracic viscera were found to be congested in 9, healthy in 5; and of 14 in which the abdominal organs were examined, congestion of the gastro-intestinal mucous membrane was found in 12 cases, and a healthy condition in two only

2. The next stage, that of **Reaction** and **Inflammation**, extends from the second day to the second week. In it, irritative fever sets in easily, with a degree of severity proportionate to the previous depression; and, as this stage advances, it is attended by special symptoms, dependent upon inflammatory affections, more especially of the abdominal and thoracic viscera. Death, which is more frequent during this stage than in the preceding one, is usually connected with some inflammatory condition of the gastro-intestinal mucous membrane of the peritoneum. The lungs also are frequently affected, showing marked evidence of pneumonia or bronchitis; but the cerebral lesions are not so common as in the first stage; though when they occur, they present more unequivocal evidence of inflammatory action. The following are the results of the *post-mortem* examinations which I have made. Of 17 cases in which the contents of the cranium were examined during this period, there was congestion, with evidence of inflammation and effusion of serous fluid, generally mixed with blood, in 14; a healthy state in the remaining 3. Of 19 cases in which the lungs were examined, there was congestion of these organs probably inflammatory in most instances; with serum or lymph in the pleura, and redness of the bronchial mucous membrane, in 10. The lungs were hepatized in 5, and healthy in 4. The abdominal organs were examined in 22 cases; of these there was congestion of the mucous membrane, sometimes with evidence of peritonitis, in 11; ulceration of the duodenum in 6; a healthy state in 5.

It is in this stage of burn, that the very remarkable and serious sequela, **perforating ulcer of the duodenum**, is especially apt to occur. Curling, who first attracted attention to it, explained its occurrence by the supposition that Brünner's glands endeavor, by an increased action, to compensate for the suppression of the exhalation of the skin consequent upon the burn; and that the irritation thus induced tends to their inflammation and ulceration. This ulceration may, as Curling remarks, by rapidly proceeding to perforation, expose the pancreas, open the branches of the hepatic artery, or by making a communication

with the serous cavity of the abdomen, produce peritonitis, and thus cause death. It usually comes on about the tenth day after the occurrence of the injury; seldom earlier than this. The only exception with which I am acquainted was in the case of a child nine years of age, who died on the fourth day after the burn, in University College Hospital, and in whom an ulcer, of about the size of a shilling, with sharp cut margins, was found in the duodenum; the intestinal mucous membrane generally being inflamed. That these ulcers are not invariably fatal, is evident from a case mentioned by Curling, in which, on death occurring, from other causes, eight weeks after the injury, a recent cicatrix was found in the duodenum. These affections seldom occasion any very marked symptoms to indicate the nature of the mischief, the patient suddenly sinking. In some instances there is hæmorrhage; though this is not an unequivocal sign, as I have several times seen it happen from simple inflammatory congestion of the intestinal mucous membrane. Pain in the right hypochondriac region, and perhaps vomiting, may also occur.

3. The stage of **Suppuration** and **Exhaustion** continues from the second week to the close of the case. In it we frequently have symptoms of hectic, with much constitutional irritation from the long continuance of exhausting discharges. If death occur, it is most frequently induced by inflammation of the lungs or pleura; affections of the abdominal organs and brain being rare during this stage of the injury.

Of 7 cases in which the lungs were examined, they were found to be healthy in one only; being hepatised, with effusion in the pleuræ, in the remaining 6 cases. Of 7 cases in which the abdominal organs were examined, a healthy state was found in 4; inflammatory congestion in 2; and a cicatrised ulcer in the stomach in 1. Of 5 of the cases the cerebral contents were found healthy in 1 only; there being inflammatory congestion in the other 4.

Prognosis.—The influence of extent, degree and situation, on the prognosis of burns has already been stated. The most fatal element indeed of these injuries is *superficial extent.* It is generally believed by Surgeons that recovery cannot take place if one-third of the surface of the body be scorched or burnt. Not only do the cutaneous nerves become greatly irritated, and the nervous system generally suffer severely, from the shock of an extensive burn; but, owing to the arrest of the cutaneous secretion over a large surface of the skin, congestion of the internal organs and of the mucous membranes ensues; hence death may happen directly from this cause, or from the supervention of inflammation in the already congested parts; more particularly in the early periods of life, when the balance of the circulation is readily disturbed. The *degree* of burn influences the prognosis unfavorably rather so far as the part itself is concerned, than as the general system is affected. The most fatal *period* in cases of burn is the first week after the accident. I find that in 50 cases of death from these accidents, 33 proved fatal before the eighth day; 27 of these dying before the fourth day. Of the remaining 17 cases, 8 died in the second week, 2 in the third, 2 in the fourth, 4 in the fifth, and 1 in the sixth.

Mode of Death from Burn.—When in an ordinary conflagration a person is "burnt to death," the fatal event is occasioned not by the charring, roasting, or actual incremation of the body, but by the induction of asphyxia. Life is mercifully extinguished by suffocation in the smoke, gases, and noxious vapors resulting from the fire, before the body itself is consumed. To what particular produce of combustion the asphyxia is

due, is somewhat undecided. There is reason to believe that in most cases it is carbonic oxide rather than carbonic acid that suffocates.

When a person is severely and extensively burnt, and dies in the course of a few hours, or a day or two, death arises usually from shock, which is most severe and continuous. Dupuytren was of opinion that during this stage the sufferer died from the excessive pain, and stated that "too great a loss of sensibility might kill as well as too great a loss of blood." Whether this be so or not, it is perhaps difficult to say; but the fact remains certain that, in individuals who die during this stage, the brain and its membranes will invariably be found congested, usually with more or less effusion of serous fluid into the ventricles and the arachnoid. This I have invariably found in every case that I have examined. In one half of the cases I have found congestion of the thoracic organs, and in the majority congestion of the abdominal organs, more especially of the mucous membrane of the stomach and ileum. Death during the second stage is usually dependent upon internal inflammation, more particularly of the gastro-intestinal mucous membrane and lungs, and less frequently of the brain and its membranes. If the patient survive into the period of suppuration, and then succumb, he will usually die from exhaustion, hastened or accompanied by inflammation of the lungs or pleura.

TREATMENT.—The treatment of burns must have reference to the constitutional condition, as well as to the local injury. A vast variety of local applications have been recommended by different Surgeons, such as flour, starch, cotton-wadding, treacle, white paint, gum, solution of India-rubber, &c.; the principle of all these applications is, however, the same, viz., the protection of the burnt surface from the air. I shall here content myself with describing the method that is usually followed with much success at the University College Hospital.

The **Constitutional Treatment** is of the utmost consequence. We have seen how death arises at various periods after these accidents from different causes, and we must modify our treatment accordingly. The first thing to be done after the infliction of a severe burn is to bring about reaction; the patient is trembling in a state of extreme depression, suffering great pain, is cold and shivering, and may sink from the shock unless properly supported. A full dose, varied according to the age, of liquor opii, should be given at once in some warm brandy-and-water, and repeated, if necessary, in the course of an hour or two.

When the body is extensively but superficially burnt, the immersion of the patient in a warm bath gives instantaneous relief, assuaging the pain and removing the depression.

When reaction has fairly set in, the patient's secretions should be kept free by the administration of an occasional mild purgative and salines. Should any inflammatory symptoms about the head, chest, or abdomen manifest themselves, it will be necessary to have recourse to treatment appropriate to their nature. I have certainly seen patients saved in these circumstances by the employment of blood-letting, and the application of leeches. But, in the vast majority of instances, the visceral complications are of a low and congestive type. In such cases our great reliance must be on stimulants. Ammonia and bark, brandy and wine, require to be freely given, with a sufficiency of nourishment; and the irritability of the nervous system must be soothed by the frequent administration of full doses of opium. At a later period, when the strength has become impaired by the profuseness of the discharges, this tonic and stimulating plan must be actively continued.

Local Treatment.—The burnt clothes having been removed, the patient should be laid upon a blanket, and, whatever the degree of the burn, be well covered with the finest wheaten flour by means of an ordinary dredger. The flour should be laid on thickly, but uniformly and gradually; it forms a soft and soothing application to the surface. If the cuticle have been abraded or vesicated, the flour will form a thick crust, by admixture with the serum discharged from the broken surface. If the skin be charred, the discharge which will be speedily set up around the eschar, will make the flour adhere to the part, forming, as it were, a coating impervious to the air. The crusts thus formed should not be disturbed until they become loosened by the discharges, when they should be removed; and the ulcerated surface that is exposed should be dressed with water-dressing, red wash, or lead ointment, according to the amount of irritation existing; the suppurating sore being, indeed, managed on ordinary principles. In some cases, lint dipped in the "*Carron oil*," composed of equal parts of linseed-oil and lime-water, to which a small quantity of spirits of turpentine might be added, has appeared to agree better than anything else: and in others cotton-wadding answers admirably. Whatever local application be adopted, I hold it to be of the utmost importance in the early stages of the burn to change the dressings as seldom as possible; not, indeed, until they have been loosened, or rendered offensive by the imbibition of the discharge. Every fresh dressing causes the patient very severe pain, produces depression, and certainly retards materially the progress of the case.

Prevention and Removal of Contraction.—As cicatrisation advances, the exuberant growth of granulations should be carefully

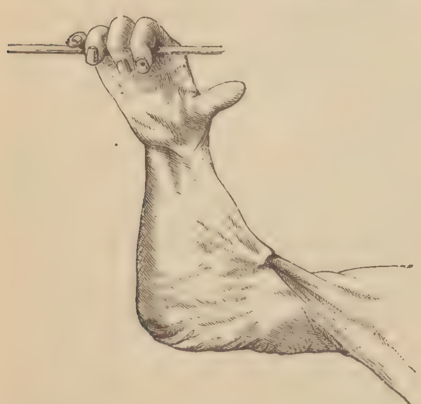


Fig. 98.—Contraction of Elbow from Cicatrix of Burn of Fourth Degree.

Fig. 99.—Contraction of Thumb from Burn of Fourth Degree.

repressed by the free use of nitrate of silver; and the part must be fixed in a proper position by means of bandages, splints, and mechanical contrivances, specially adapted to counteract the tendency to contraction of the cicatrix, and the consequent deformity. This is especially necessary in burns about the neck, where the chin is liable to be drawn down on the sternum; and in burns at the inside of limbs or the flexures of joints, more especially the elbow, where contraction is very apt to ensue. (Fig. 98.) In bad burns of the hands, the fingers may be drawn into and fixed upon the palm of the hand, may become webbed together, or may

be dislocated and fixed immovably against the dorsum. The accompanying woodcuts are good illustrations of the bad effects of burns upon the hands. In Fig. 100 the little finger has been dislocated backwards, and fixed upon the dorsum. In Figs. 101 and 102, the two hands were frightfully deformed—the fingers being partly consumed, and partly webbed and matted together by dense cicatricial tissues. This accident occurred in consequence of the night-shirt taking fire. The patient tried to extricate himself by drawing the burning garment over his head, but, the wristbands being buttoned, he could not withdraw the hands, which were frightfully burnt. Fig. 99 represents the thumb drawn into such a position as to be no longer capable of being brought into apposition

Fig. 100.—Dislocation backwards of Little Finger from Contraction of the Cicatrix of a Burn of the Fourth Degree.

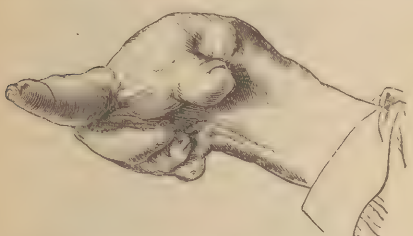


Fig 101.—Deformity of Right Hand from Burn of the Fourth or Fifth Degree.

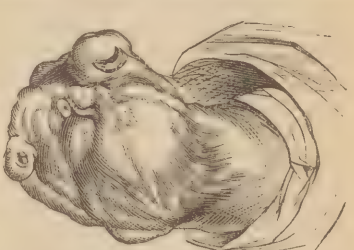


Fig. 102.—Deformity of Left Hand from Burn of the Fifth Degree.

to the fingers. In the early treatment of such cases, I have advantageously employed the elastic traction of India-rubber bands to counteract the tendency to contraction of the scar.

Similar contractions may occur in the foot, leaving great deformity, as in Fig. 103, where the heel is shown to be retracted, and the whole of the toes spread out in a fan shape. In this case amputation (Pirogoff's) was the only means left for securing an useful limb.

Fig. 103.—Deformed Foot from Burn of the Fourth and Fifth Degrees.

Corrosive liquids, such as strong sulphuric acid, when applied to the surface, produce very similar effects to those that result from the more severe degrees of burn; leaving cicatrices contracted, irregular, and often, as in Fig. 104, rugged and warty.

The contracted cicatrices resulting from burns may, if of recent date, be stretched out by the pressure of strips of plaster, the traction of India-rubber

Fig. 104.—Warty Cicatrix of Arm resulting from action of Sulphuric Acid.

bands, or the action of rack-and-pinion apparatus. The good effect of this plan of treatment is especially marked in contractions at the elbow, or in those that fix the arm to the side. These means are particularly useful in children, and indeed are so in all cases, provided the cicatrix be not too old—not more than a year; after that time it will seldom yield without division.

Operations for the Removal of the Effects of Contraction consequent upon burns are occasionally required; and, if judiciously planned and executed, may do much to remedy the patient's condition. The operations that are practised with this view are of two kinds: 1. Simple division of the Faulty and Contracted Cicatrix; 2. The Transplantation of a flap of adjacent healthy Skin into the gap left after the division of the cicatrix.

1. In the first operation, that of simply **Dividing the Cicatrix,** three points require special attention: 1st, that the division extend completely through the cicatrix from side to side into the adjacent healthy skin; 2d, that the incision be carried through the whole depth and thickness of the cicatrix into the healthy cellulo-adipose layer which will be found beneath it, and may always be recognized by its yellow color; 3d, that all contractile bands lying in this layer be fairly divided. The great obstacle to the success of this operation, however, consists in the fact that the new granulations, which spring up after the division of the contracted cicatrix, are in their turn liable to take on contractile action. After the division of the circatrix, also, it may be found that the subjacent structures have been so rigidly fixed in their abnormal position as not to admit of extension. It may then be necessary to employ screw-apparatus, or even to divide fasciæ and tendons, before the part can be restored to its normal shape. Care must, however, be taken in doing this, that subjacent structures of importance, such as large bloodvessels, or nerves, be not so closely connected with the cicatrix as to render wound or division of them unavoidable. In the neck, cicatricial bands will often come into very dangerous proximity to the external jugular vein, which becomes greatly distended by the pressure thus exercised upon it. And at the elbow, which is a common seat of contraction from burns, the brachial artery may become involved in the cicatrix to a dangerous extent. I have heard of one case in which this vessel was divided in cutting through the cicatrix, when amputation of the arm was immediately resorted to.

These operations are most successful in cases of contraction at the flexures of the joints, as of the elbow. There, all that need be done is to divide the cicatrix down to the subjacent healthy structures, and then, by the application of splints or screw apparatus, gradually to extend the limb, and allow granulation to go on in the extended position. Much caution, however, will here be necessary; for, if the contraction be of very long standing, the arteries and nerves will have become shortened, and incapable of stretching under any force that may be safely employed; hence they may easily be torn.

2. Operations that are undertaken for the removal of the disfigurements that occur about the face and neck as the result of burns, require much management. In these cases, simple division of the cicatrix is insufficient; and **Transplantation of a Flap of Skin** is required in addition. After the cicatrix and all cicatricial bands have been freely divided in accordance with the rules just given, a flap of integument, of sufficient size to fill the greater part of the gap, must be dissected up from the neighboring parts of the neck, chest, or shoulder, and laid into

the cicatrix. There it should be fixed by two or three points of suture; but extreme care must be taken that no traction be put upon it, lest it slough. Union takes place by the second intention in the majority of instances; but a very satisfactory result is left, as is shown by the annexed figures (105, 106), taken before and after operation, and as has been illustrated in many cases by Mütter and Teale, who have particularly distinguished themselves in such operations. The directions given by Teale for the restoration of the lower lip when dragged down, everted, and partially destroyed, by cicatrisation following burn, are so simple and lead to such excellent results, that I give them nearly in his own words. The everted lip is divided into three parts, by two vertical incisions three-quarters of an inch long, carried down to the bone. These

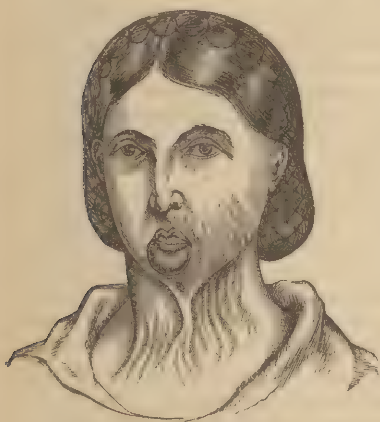


Fig. 105.—Cicatrix of Lip and Neck before Operation.

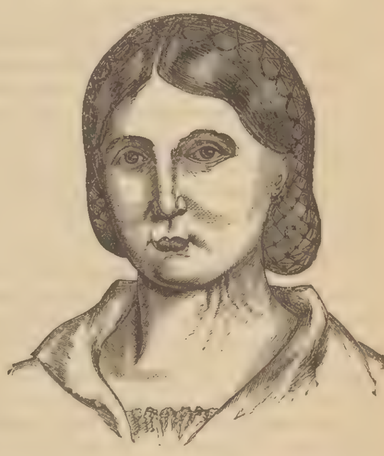


Fig. 106.—The same Patient after Operation.

incisions are so planned that the middle portion between them (Fig. 107, B) occupies one-half of the lip. From the lower end of each incision the knife is carried upwards to a point one inch beyond the angle of the mouth (A). The two flaps thus marked out are freely and deeply dis-

Fig. 107.—Incisions in Teale's Operation for Cicatricial Deformity of the Lower Lip.

Fig. 108.—Teale's Operation: the Flaps in Place.

sected up. The alveolar border of the middle portion is then freshened. The lateral flaps (Fig. 108, C A) are now raised, united by twisted sutures in the mesial line, and supported as on a base by the middle flap, to which they are also attached by a few points of suture, leaving a triangular even surface (C C) to granulate. In addition to the division of the cicatrix, James, of Exeter, in these cases very successfully

employed a screw-collar, by which the chin can be loosened from the sternum, and gradual extension of the cicatrix effected.

In severe burns of the side of the face and neck the resulting cicatrix is sometimes so dense, resisting, and contracted, that immobility of the jaw results and the mouth cannot be opened, or at most the teeth can only be separated to a slight extent, so as to admit liquid nourishment. In order to restore the mobility of the jaw and the power of separating the teeth in these cases, Rizzoli and Esmarch have proposed making a false joint in the lower jaw on the side burnt, immediately in front of the cicatrix. Rizzoli does this by simple division of the bone by means of a narrow saw: Esmarch recommends, as a more effectual procedure, the removal of a wedge-shaped piece of bone about three-quarters of an inch in width above and one inch in width below. After this has been done, the patient will be able to move the jaw at the normal articulation on the healthy side and at the false joint where the jaw has been cut across.

Warty Cicatrices.—The cicatrices of burns, especially on the neck and chest, occasionally become after a time projecting, red, and glazed, as if composed of a mass of fungating granulations, smoothed down and lightly skinned over. This condition, which may be looked on as a substantive disease, and resembles keloid in appearance, has chiefly been met with in children; but I have several times seen it in adults, especially in women who had been badly burnt by their dresses taking fire. In these cases I observed what I have noted in other similar instances in children; that the warty cicatrices were the seat of the most intolerable itching, which no external application seemed to relieve. I have, however, seen the pruritus mitigated by the administration of large doses of liquor potassæ. If small and narrow, these cicatrices may be dissected out; if large, they cannot be removed without risk of much hæmorrhage; for, although fibroid, they are very vascular.

The cause of this peculiar outgrowth of dense cicatricial tissue is altogether unknown. It may in some cases, perhaps, be owing to want of care in checking the luxuriance of the granulations; but in other cases it occurs though every attention is paid to the healing of the wound.

The cicatrix of a burn may become the seat of a malignant growth many years afterwards. I have removed a large epithelioma from the cicatrix of a burn, on the fore-arm of a woman, seventy years after the injury had been inflicted, which happened when she was three or four years of age.

Primary Amputation may be required if the burn have destroyed the whole thickness of a limb; the part charred should then be removed at once, at the most convenient point above the seat of injury. This operation may also be required at a later period, if, on the separation of the eschars, it be found that a large joint has been opened, and is suppurating; or if the disorganisation of the limb be so great as to exhaust the powers of the patient in the efforts at repair. Great caution, however, should be employed in determining on the propriety of amputating when the burn has extended, though in a minor degree, to other parts of the body, lest the powers of the patient be insufficient for the double call that will thus be made upon them.

FROST-BITE.

When the body has been exposed to severe or long-continued cold, we find, as in the case of burns, that local and constitutional effects are produced.

Local Influence of Cold.—This is chiefly manifested on the extremities of the body, as the nose, ears, chin, hands, and feet, where the circulation is less active than at the more central parts. It chiefly occurs to an injurious degree in very young or aged persons, or in those whose constitutions have been depressed by want of the necessaries of life. In such persons frost-bite and the resulting gangrene are less due to the low temperature to which they are exposed, than to the habitual low vitality of the extremities.

In the first degree of frost-bite that calls for the attention of the Surgeon there is a feeling of stiffness, with complete numbness of the part that has been exposed to cold; it is pale, with a bluish tint, and somewhat shrunken. In this state the vitality of the part is not destroyed, but merely suspended. On the return of circulation in the affected part, a burning tingling pain is felt, the part becomes red, and shows signs of a tendency to inflammatory action. Indeed, this appearance of inflammation, often accompanied by a burning sensation, is probably the immediate consequence of extreme degrees of cold, as it is experienced on touching solidified carbonic acid or frozen mercury.

In the next degree, the vitality of the part is completely destroyed; all sensibility and motion in it are lost, it becomes shrunken and livid; but though its vitality may have been annihilated by the immediate application of the cold, it is not until the part has become thawed that gangrene usually manifests itself; it then appears to do so by the violence of the reaction induced, the part rapidly assuming a black color, becoming dry, and separating eventually, as all other mortified parts do, by the formation of a line of ulceration around it.

The *Constitutional Effects* of a low temperature need not detain us. It is well known that, after exposure to severe or long-continued cold, a feeling of heaviness and stupor comes on, and gradually creeps on to an overpowering tendency to sleep, which, if yielded to, terminates in coma, and a speedy, though probably painless, death.

Treatment of Frost-Bite.—This consists in endeavoring to restore the vitality of the frozen parts. In doing this the great danger is, that reaction may run on to so great a degree as to induce sloughing of the structures, the vitality of which has already been seriously impaired. In order to prevent this accident, the temperature must be elevated very gradually and with extreme care. The patient should be placed in a cold room, without a fire, any approach to which would certainly lead to the destruction of the frost-bitten members. These must then be gently rubbed with snow, or with cloths dipped in cold water, and held between the hands of the person manipulating; as reaction comes on, they may be enveloped in flannel or woollens, and a small quantity of some warm liquid or spirit and water may be administered. In this way sensibility and motion will be gradually restored, often with much burning and stinging pain, redness, and vesication of the part. If gangrene have come on, or if the reaction run into sloughing, the sphacelated part, if of small size, should be allowed to detach itself by the natural process of separation, which should be as little interfered with as possible, the vitality of the parts continuing at a low ebb, and extension of gangrene being readily induced. If the gangrenous parts be of greater magnitude, amputation may be required. This should be done at the most convenient situation, as soon as the line of separation has fully formed.

If the person who has been exposed to cold be apparently dead, he must be put in a cold room, the temperature of which must be very

slowly raised. Friction, as just described, should be practised, and artificial respiration set up. These means must be continued for a long time, even if no signs of life appear: there being on record instances of recovery after several hours of suspended animation.

CHAPTER XIII.

INJURIES OF BLOOD-VESSELS.

INJURIES OF VEINS.

VEINS are very commonly wounded suicidally, accidentally, or in surgical operations; but, unless they be deeply seated, their injuries are seldom attended by any serious consequences. Occasionally subcutaneous rupture or laceration of a vein takes place from a blow or strain. In such cases extensive extravasation of blood will occur, which, however, usually undergoes absorption in a few weeks; but it may suppurate, or take on itself the changes described at page 202. This accident is most commonly seen in the saphena vein.

There are three sources of danger in open wounds of veins: 1, Loss of Blood; 2, Diffuse Inflammation of the Vessel; 3, Entrance of Air into the Circulation.

1. A vein is known to be wounded, when dark blood flows in a rapid and uniform stream from the seat of injury. If the vessel wounded be one of considerable magnitude, or in close proximity to the centre of the circulation, the flow of blood may be rapidly fatal, more especially if its escape be favored by the dependent position of the part.

The **Hæmorrhage** from a wounded vein may, if the vessel be superficial, be arrested by position, and the pressure of a compress, with a few turns of a roller. If the vein be one of considerable size, as the internal jugular, or if it be so situated that pressure cannot be brought to bear on it, it may require the application of a ligature; but this should, if possible, always be avoided, inasmuch as it is apt to occasion dangerous inflammation of the vessel.

The wound in a vein is healed by a slight inflammation taking place about the lips of the incision, and giving rise to the formation of a distinct cicatrix without occlusion of the vein.

2. In some cases, from the irritation of the simple wound, and in others from the application of the ligature, a **Diffuse Inflammation of the Vein** takes place, which usually proves fatal. The variety of phlebitis will be described when we come to speak of the different kinds of venous inflammation.

3. The *Entrance of Air into Veins*, being a subject of much importance, will be discussed in a subsequent chapter.

INJURIES OF ARTERIES.

Arteries may be bruised, torn, punctured, or cut.

CONTUSION.—A slight bruise of an artery is not attended by any bad consequences; but, if the contusion be severe, obliteration of the vessel by adhesive inflammation may ensue some days after the accident.

Contusion = Bruise

Thus, a patient was admitted into University College Hospital under Mr. Quain, with a contused wound in the axilla, received in falling upon some iron railings; no change took place in the circulation of the arm for two days, when pulsation in the radial artery ceased, the injured vessel having evidently become plugged by plastic deposit.

Rupture and Laceration.—An artery may be torn either partially or completely across. When **Partial Rupture** occurs, the internal and middle coats only give way, the toughness of the external coat preventing its laceration. This accident is especially apt to occur in consequence of blows or strains upon diseased or weakened vessels, and thus may possibly lay the foundation for dissecting and other aneurisms. In other cases, the ruptured portion of the coats becomes turned down into the inside of the vessel, and, acting as a valve, prevents the further progress of the blood through it, thus giving rise to gangrene of the limb. In some cases the partially ruptured vessel becomes blocked up by plastic matter, occluding its interior, but without producing gangrene.

The **Complete Rupture** of an artery may occur either in an open wound or under the integuments. When an artery is torn across in an open wound, as in the avulsion of a limb by machinery, or by a cannon-shot, there is usually but little hæmorrhage, even from arteries of the magnitude of the axillary or the femoral, and though the vessel hang out of the wound, pulsating to its very end. The absence of bleeding is owing to the internal and middle coats, which are fragile, breaking off short and contracting somewhat; while the external coat and the sheath of the vessel, being elastic, are dragged down and twisted over the torn end of the artery, so as completely to prevent the escape of blood.

When the laceration of the artery is subcutaneous, as occasionally happens in the attempted reduction of an old dislocation of the shoulder, either extensive extravasation, or one or other of the varieties of *Traumatic Aneurism*, to be described in Chapter XV., may be produced.

Wounds of Arteries, whether punctured or cut, may be divided into those that do not penetrate into the interior of the vessel, and those by which it is completely laid open.

Non-penetrating Wounds of arteries are very rare. Guthrie, however, relates the case of a gentleman who cut his throat, and in whom the carotid artery was exposed and notched through the external and middle coats only; the vessel finally gave way on the eighth day, death ensuing. A case has also occurred at the London Hospital, in which a suicidal wound of the throat had exposed the carotid artery. After death it was found that the inner and middle coats of the vessel had been divided by the pressure of the knife, which was blunt, but that the external coat had been left entire, and under this a dissecting aneurism was found.

In **Penetrating Wounds** of an artery, there is always hæmorrhage of an arterial character unless the puncture be so fine as to be closed by the mere elasticity of the coats of the vessel. Thus, Maisonneuve has shown that an artery may be punctured with a fine needle, without any hæmorrhage or other unfavorable event resulting. If, however, the puncture be larger than this, being made by a tenaculum or hook, it does not commonly close in this way; and if hæmorrhage do not take place immediately, it will probably come on in the course of a few hours or days, from ulceration of the vessel. If the wound be still larger, there is always an amount of immediate hæmorrhage proportionate to its size and to that of the vessel.

The *Direction* of the wound in the artery influences materially its

characters. If the cut be parallel to the axis of the vessel, there is less tendency to gaping of the edges than if it be oblique. In transverse wounds of arteries, the retraction of the coats is so great as to cause the wound to assume somewhat of a circular appearance. If the artery be cut completely across, there is always a less degree of hæmorrhage than when it is partially divided; for the retraction and contraction of the cut ends may then be sufficient to close the vessel, which is not the case when it is merely wounded. When the wound in the artery is subcutaneous, communicating only by an oblique and narrow aperture with the surface, little, if any, external hæmorrhage takes place, but extravasation of blood occurs. The extravasation may either be poured into one of the serous cavities, or it may be diffused in the areolar tissue of the limb or part, infiltrating it deeply and extensively, and perhaps by its pressure ultimately producing gangrene; or it may be effused in a more circumscribed manner, giving rise to one or other of the forms of traumatic aneurism (see Chapter XV.).

HÆMORRHAGE FROM WOUNDED VESSELS.

Local Signs.—The characters of the bleeding or hæmorrhage differ according to the nature of the vessel from which the blood escapes. When a **Vein** is wounded, the blood that is poured out is of a dark color, and flows in a uniform stream; the force with which this is projected depending on the conditions in which the wounded vein is placed. If there be any pressure between the wound and the heart, as of a ligature upon the vessel; if the position of the part be such as to favor the gravitation of the blood towards the wound; or if the muscles of the limb be made to contract, the force of the flow of blood will be increased.

When an **Artery** is wounded, the blood that escapes is of a bright vermilion or scarlet color. It flows by jets, synchronous with the contractions of the left ventricle; between the jets the flow does not cease, but the stream becomes continuous. In the great majority of cases the jet comes only from the proximal aperture, dark blood issuing from the distal opening in a continuous and trickling stream; but in some situations a jet of blood of arterial character may issue from the distal as well as from the proximal end of the cut vessel, as in wounds of the palmar and plantar arches, or of the arteries of the forearm. As the blood flows, the jet lessens in height, in consequence of the weakening of the heart's action. The height and force of the jet in all cases depend greatly on the size of the vessel; thus the jet from the femoral artery is stronger than that from a muscular branch of the thigh. When a small arterial branch is wounded near its origin from the main trunk, the jet will always be forcible and free; so also the proximity to the centre of the circulation will influence materially the force with which the blood is propelled from the wound in the vessel.

Extravasation.—When the blood is not poured out on the surface, but escapes from a wounded vessel into the areolar tissue of a part, the substance of organs, or internal cavities, it is termed an *Extravasation.* In these cases there are not the ordinary local signs of an external hæmorrhage; but other local phenomena, such as swelling, dulness on percussion, displacement of organs or parts, discoloration of the skin and subjacent areolar tissue, indicate that blood is being poured out subcutaneously; and we judge of the quantity of the blood that has escaped, not only by the extent of these local phenomena, but by the general effect produced upon the system by its loss.

Constitutional Effects of Hæmorrhage.—These depend upon the quantity of blood lost, on the rapidity with which it is poured out, on the state of the patient's constitution, and on the vessel which furnishes the blood.

When a large quantity of blood is suddenly lost, as when a main artery is cut across or an aneurism bursts, the patient may die forthwith; he falls down in a state of syncope, with a pale cold surface, and lividity about the lips and eyes, and gasps a few times, sighs, is very restless, and suffers convulsive movements of the limbs before he expires. If the quantity lost be not so great as to produce death, but be yet very considerable, the patient becomes faint and sick, with coldness and pallor of the surface, great restlessness and agitation, thirst, noises in the ears, and failure or complete loss of sight. If the quantity lost, though considerable, be not so great as this, or be spread over a greater interval of time, so that the patient is enabled to rally between the recurrences of the hæmorrhage, a state of anæmia will be induced, characterised by pallor of the skin and of the mucous membranes, palpitation of the heart, rushing noises in the head, amaurosis, a tendency to syncope when in the erect position, œdema of the extremities, and general debility of the system.

After excessive loss of blood the patient may gradually rally, and, as the vital fluid is reproduced in his system, he may recover without any bad effects; or he may fall into a state of anæmia, which may perhaps never be completely recovered from, and may be associated with various forms of local debility and disturbance of functions. After very abundant loss of blood, "hæmorrhagic fever" is apt to set in, characterised by a tendency to reaction in the system, with extreme irritability of the heart and arteries. It is irritative fever conjoined with anæmia. There is but a small quantity of blood in the system, and the heart and arteries make violent efforts to drive it forwards. This condition is marked by the symptoms of extreme loss of blood, alternating with periods of intermittent reaction; the pulse becomes much hurried, fluttering, jerking, and irregular in force and frequency; there are slight flushings of the face and brilliancy of the eyes, rapidly passing again into pallor and syncope; and if the hæmorrhage eventually prove fatal, delirium and convulsions, with excessive restlessness, usually precede death. The rallying power is greater in the young than in the old, and greater in women than in men. In advanced life blood is slowly reproduced; and a great loss of so complex a fluid, whether by accident or in an operation, is seldom completely recovered from, and often leads to the development of dangerous or even fatal secondary diseases of a low type. As has already been stated at p. 37, it is in this way that excessive loss of blood at an operation, as for stone in the aged man, often proves indirectly and remotely fatal. The body of a person who has died from the effects of hæmorrhage presents a particularly blanched, semi-transparent, waxen look; the lips, alæ of the nose, and finger-nails, have a somewhat livid appearance, contrasting strongly with the clear, yellowish-white hue of the general surface. Arterial is more dangerous than venous hæmorrhage. The same quantity of blood poured out from a wounded artery will produce a greater effect on the system than an equal loss of blood from a divided vein. Children bear the loss of blood badly—a very small hæmorrhage may induce fatal syncope in infants.

Treatment.—The *General Treatment* of hæmorrhage is sufficiently simple. After the flow of blood has been arrested by proper local means, such as will hereafter be described, the effects of its loss are

usually speedily recovered from by rest and good nourishment. In some cases, however, the nutritive process becomes permanently impaired, and a state of chronic anæmia is induced; which, notwithstanding the administration of chalybeate preparations, may continue through life, and terminate in cachexia, phthisis, or diarrhœa.

When the loss of blood is considerable, and is attended by symptoms of much prostration, it may be necessary to have recourse to immediate measures in order to prevent the syncope from being fatal. With this view the patient should be laid recumbent, with the head low; and pressure may be exercised upon the abdominal aorta or the main arteries of the limbs, or Esmarch's elastic bandage and tourniquet may be applied, so as to confine the blood as much as possible to the nervous and circulatory centres. If death appear imminent from the effects of the hæmorrhage, as happens in some cases of flooding, recourse may be had to transfusion of blood; the influence of which, in restoring the failing powers of the heart and nervous system, is immediate and most striking, and has been unquestionably determined by the observations of Blundell and other obstetricians.

Operation of Transfusion.—Although there is reason to believe that Transfusion of Blood was not unknown to the ancients, and the method by which it could be practised was distinctly described by Libavius in 1615, little was done on the subject until Sir Christopher Wren, in 1657, proposed and practised the operation of injecting medicated liquids into the veins of animals. The operation was first performed on man in France, by Denis and Emmerets, on June 15, 1667. In November of the same year, it was done in this country by Drs. Lower and King. In the early experiments, the blood of sheep and calves was used. The most extravagant ideas were formed as to the utility of transfusion. It was supposed to be capable of curing diseases by substituting the blood of a healthy animal for that of a diseased person, of removing insanity by the injection of the blood of animals of a gentle and docile character into the veins of a maniac, and of prolonging life indefinitely. These pretensions led to a scientific controversy of the most violent kind; and, some deaths having occurred from the practice, partly in

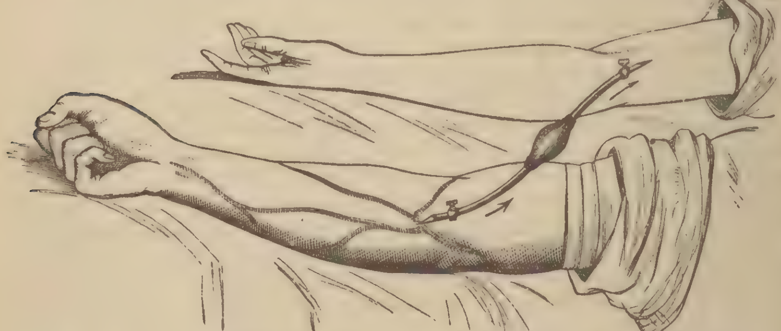


Fig. 109.—Aveling's Method of Transfusion. A, Arm of Donor; B, Arm of Recipient.

consequence of the rude and imperfect instruments used, transfusion was prohibited in France, and fell into disrepute in England. Although the subject was occasionally revived, little attention was paid to it until about fifty years ago, when transfusion was again practised by Dr. Blun-

dell, who wisely restricted its employment to those cases chiefly occurring in obstetric practice, in which, in consequence of sudden and profuse hæmorrhage, the patient is threatened with a fatal syncope. Dr. Blundell invented a syringe by which the operation might be more safely performed than had heretofore been done; and by his practice, experiments, and arguments, established the system on a secure basis.

Since his time, many improvements have been made in the method of performing transfusion. Up to a recent period, this was invariably done by receiving the blood from the donor into a vessel of some kind, and thence pumping it into the veins of the recipient. But this method is attended by two sources of danger, which no mechanical provisions are sufficiently accurate entirely to prevent, viz., the introduction of air, and the coagulation of the fibrine of the blood. Dr. Aveling has, however, overcome these difficulties by the employment of an apparatus, which is seen in operation in Fig. 109.

Aveling's transfusion apparatus consists of two silver bevel-ended tubes, one of which is introduced into the vein of the donor, the other into that of the recipient. The vein should be opened as recommended by Aveling, by exposing the vessel, and then making a sharp cut into it (Fig. 110). The India-rubber part of the apparatus is filled with warm water, which is retained there by turning the two stop-cocks. It is then fitted on to the tubes in the veins, and the stop-cocks opened. The India-rubber tube on the efferent side is then compressed, and the bulb slowly squeezed, so as to empty the water which it contains into the recipient vein. The tube on the recipient side is then compressed, and that on the efferent opened; the bulb slowly fills with blood, which is then injected by compressing the efferent and opening the recipient tube, and so alternately until a sufficient quantity is thrown in.

Fig. 110.—Introduction of Transfusion-pipe into Vein.

A very ingenious apparatus for the performance of direct transfusion has lately been introduced into this country by Dr. Roussel, of Geneva, who invented it as long ago as 1864. It is so designed as to render the entrance of air during the operation almost impossible, and is made of natural black caoutchouc, in contact with which the blood is said to coagulate much more slowly than with any other material. The instrument consists of a rigid cylinder of vulcanite, which is surrounded by a cup of the same material. When applied to the arm, the edges of the cup and the lower end of the cylinder press upon the skin, and the instrument is fixed in position by exhausting the air contained in the space between the cup, the cylinder and the skin by means of a powerful India-rubber ball, which is connected with the space by a tube. It must be so applied that the vein will be seen on looking down the cylinder exactly in the centre of the space enclosed by its lower end. The cylinder has two tubes opening into it, one fitted with a stop-cock, leading to a basin containing warm water, and the other fitted with a Higginson's syringe capable of containing 10 grammes of fluid. Beyond the syringe the tube divides into two parts, one of which is fitted with a vulcanite

nozzle to be introduced into the vein of the recipient. A stop-cock is fitted at the junction of these tubes, so that the stream from the syringe may be directed into either at will. The upper end of the cylinder is closed during the performance of the operation by an accurately fitting plug of vulcanite, through the middle of which passes a small lancet, which can be driven down into the vein by pressing a button at the top of the plug, and is then retracted again by a spring. The depth to which the lancet can be depressed is accurately regulated by a small screw, and it is so arranged that no air can enter beside it. Everything being ready, the cup and cylinder firmly fixed, and the vein (at a point which is not over the artery) exactly in the centre of the lower opening of the cylinder, the plug is inserted into the upper opening. By a few actions of the syringe a quantity of water is drawn in by the afferent tube, which expels the air from the cylinder, and fills it and the efferent tubes with water when the stop-cock leading to the afferent tube is closed. The nozzle is then inserted into the vein of the recipient, and the stop-cock turned so as to direct the flow to the other efferent tube. The lancet is now driven sharply down into the vein, and is immediately retracted by the small spring, and the vein is thus opened under water. On working the syringe the blood is aspirated from the open vein, and flows into the efferent tube, which is open. As soon as pure blood begins to flow, the stop-cock is turned so as to open the tube connected with the cannula in the vein of the recipient, and close the other. The small quantity of water contained in this tube and the cannula is then driven on into the vein, and afterwards pure blood can be pumped in as long as is necessary.

The operation of transfusion is one of much delicacy, requiring special care lest one of two accidents happen, viz., the injection of air into the patient's veins, or of a fibrinous embolon. The first danger is obviated by filling the transfusing apparatus with warm water; the second, by not allowing the blood to coagulate in it. The blood may be defibrinated without losing its properties as a restorative; and in the event of proper transfusing apparatus not being available, and the Surgeon having to use an ordinary hydrocele or aspirator syringe, it would only be wise to take this precaution. Panum, of Copenhagen, has clearly shown by numerous experiments that the fibrine is not in any way necessary to the success of the operation. He recommends that the blood be drawn into a cup kept warm in a basin of hot water. It is then to be well whipped, filtered through a fine cloth, and injected. The essential part of the blood is the red corpuscles, which are wanted to serve as carriers of oxygen. The removal of the fibrine in this way materially facilitates the operation, which is otherwise attended by some difficulty owing to the liability to coagulation of the blood in the transfusing apparatus, or by danger from embolism from the injection of coagulum into the veins. If transfusion be determined on, it should not be delayed until the last moment, when the agony of death has already commenced; as then the actions of the nervous and circulatory systems may be so impaired that the patient is no longer recoverable, or, if temporarily so, will speedily lapse into a state of fatal disease.

The *Local Treatment* of hæmorrhage will be fully described in the next chapter.

CHAPTER XIV.

ARREST OF ARTERIAL HÆMORRHAGE.

THE arrest of arterial hæmorrhage is perhaps the most important topic that can engage the Surgeon's attention, as on the safe accomplishment of this the success of every operation is necessarily dependent. In studying this subject we must first investigate the Means that are adopted by Nature for the Suppression of Hæmorrhage; and, secondly, the imitation of these by Surgical Art.

NATURAL ARREST OF HÆMORRHAGE.

The history of the investigations into the means adopted by nature for the arrest of hæmorrhage is full of interest to the Surgeon, and is excellently given in Dr. J. F. D. Jones's work on Hæmorrhage. No subject in surgery affords a stronger evidence of the advantage of the application of "Experimental Pathology" to practice, than this, as our knowledge of it has been wholly gained by experiments on the lower animals; and by the sacrifice of the lives of a few dogs, donkeys, and calves, those of hundreds—probably of thousands—of human beings are annually preserved.

Petit, who published several memoirs on this subject in 1731 and following years, states that hæmorrhage is arrested by the formation of two clots—one outside the vessel which he calls the "Couvercle," or Cover; the other inside, the "Bouchon," or Plug—the first being formed by the last drops of blood that issue, the second by the few drops that are retained. These clots by their adhesion to the internal coat of the vessel and to the orifice, he says, stop the bleeding. When a ligature is applied, a similar clot forms above it. He recommends compression, and the support of the clot.

Morand, in 1736, added much of interest. He admitted the formation of coagula, but insisted on the importance of the changes in the artery itself; which, he showed, became corrugated, contracted, and retracted. Morand entertained erroneous views as to the structure and functions of arteries, but he established the great fact that changes occur in the artery itself. Sharp, in the second edition of his work on Operative Surgery, published in 1739, supported the same doctrine.

Kirkland, in 1763, wrote an excellent treatise on the subject. He showed that hæmorrhage was lessened by swooning, and that an artery contracted up to its nearest collateral branch; and he was of opinion that the coagulum did not arrest the bleeding. His views were adopted and supported by White, Gooch, Aikin, and other surgeons of his day.

J. Bell took a retrograde step by denying the retraction and contraction of the artery, and the importance of the internal coagulum, and by attributing the arrest of hæmorrhage solely to the injecting of the surrounding areolar tissue with blood.

It was not until 1805, that Dr. Jones, by a series of admirably conducted investigations, finally determined the mode in which the arrest of hæmorrhage takes place. Since his time but little has been added to

our knowledge of the subject, so complete and exhaustive was his examination of it.

The *Natural Arrest of Arterial Hæmorrhage* is effected by means that in the first instance are *temporary*, but afterwards *permanent*.

TEMPORARY MEANS.—The means which arrest temporarily the flow of blood from an artery are threefold. If the vessel be small, as the facial or radial, these means are sufficient in many cases to stay the hæmorrhage without the interference of the Surgeon; and, whatever be the size of the vessel, his operations are materially assisted by the efforts which nature makes, though they may be sometimes unsuccessful, to prevent a fatal escape of blood. They consist in:

1. The Coagulation of and an Alteration in the Constitution of the Blood;

2. A Diminution of the Force of the Heart's Action, and consequently of the pressure on the inner coat of the vessel;

3. Certain Changes effected in and around the Artery.

1. The **Coagulation of the Blood** in and around the wounded artery is the first and most important means adopted by nature for the arrest of hæmorrhage. Were it not for the property of coagulation possessed by the blood, that fluid would continue to drain away from any cut artery, however small, until life became extinct. But the coagulation of the blood is sufficient of itself, in most cases, and in all cases of vessels below a certain size, to close the opening in the artery, and so to arrest the further escape. The *Alteration that takes place in the Blood* consists in an increase of its coagulability as it flows. The blood that escapes from a wounded artery has from the first a tendency to glaze and coagulate about the cut vessel, so as to offer a mechanical obstacle to the further escape of the fluid. This of itself is sufficient in the smaller vessels to arrest the hæmorrhage; the more so, as has been pointed out by Hewson, in consequence of the last flowing blood being more coagulable than the first.

2. The **Diminution in the Force of the Heart's Action,** owing to the patient becoming faint or collapsed, exercises a very material influence in arresting the flow of blood from an artery. The forcible manner in which the jet of blood is propelled at each systole of the ventricle, is the principal obstacle to the coagulation of the blood around and within the cut vessel; for not only does the movement of the blood prevent coagulation, but, so long as the jet is more powerful than the cohesion of the clot, it will certainly wash the coagulum away. As the blood flows, and the heart's impulse gradually lessens in force, the jet falls lower and lower; until at last, when faintness comes on, it is almost entirely arrested, and time is afforded for the formation and the deposit of a coagulum in the vicinity of the wound. The collapse consequent on excessive and sudden loss of blood may therefore be looked upon as one of the provisions of nature for the safety of the patient, and should therefore not be too speedily counteracted by stimulants or in any other way.

3. The **Changes that take place in and around the Vessel itself** are those upon which the final arrest of the bleeding is dependent. They consist in the *Retraction* of the artery within its sheath, in the *Contraction* of the cut ends, and in the *Formation of a Coagulum* around its exterior, and in its interior.

When an artery is cut across, it immediately **retracts within its sheath,** the interior of which is left rough and uneven. Through this uneven channel the blood is projected, either flowing freely externally or being extravasated into the neighboring areolar tissue, according to

the direction and state of the wound. As the blood flows over the roughened surface of the sheath, it becomes entangled in the fibres, and tends to coagulate upon them; this tendency to coagulation is favored by the increased plasticity of the blood as it flows, and by the diminution of the propulsive force with which it is carried on. By the conjoined operation of these causes a coagulum is formed, which, though lying within the sheath, is outside the artery, and extends beyond it; and is hence termed the **external coagulum**. It is usually somewhat cylindrical, and often looks like a continuation of the vessel, being at first perforated by a hollow track, through which the stream of blood continues to flow. As it increases in size, the hollow becomes closed by the concentric deposit of coagulum. The hollow track leading from the surface of the coagulum to the wound in the artery, has been especially described and dwelt upon by Amussat. This coagulum acts mechanically by blocking up the end of the artery, and also by compressing the vessel within the sheath; thus constituting the first barrier to the hæmorrhage. The formation of the external coagulum is thus in a great measure dependent on the retraction of the artery within its sheath.

The next changes that take place in the artery, and, indeed, that are to a certain extent simultaneous with those that have just been described, are, its *Contraction* and the formation of *Internal Coagulum.*

The **Contraction** of the cut artery commences immediately after its division, and may of itself be sufficient to close a small vessel. Thus, during an operation, we may often see an artery which, when first cut, spouted out a stream of blood as large as a straw, gradually contract in size until it ceases to bleed, owing simply to this contraction. In a larger artery this process is not sufficient to completely close the vessel, but merely gives its cut end a conical shape, diminishing greatly the aperture in the artery, perhaps to the size of a pin-hole.

In proportion as the open end of the artery is obstructed by the external coagulum and contracts in diameter, the blood is propelled with more and more difficulty through it, until at last it escapes in but a small and feeble stream, or even becomes completely stationary, allowing its fibrine to be deposited in a slender coagulum, which plays a more important part in the permanent than in the temporary arrest of the bleeding. To the formation of this **Internal Coagulum** the contraction of the vessel is subservient. This coagulum is slender and conical, the base being attached to the margins of the aperture in the vessel, and the apex extending upwards. It has no point of attachment, except by its base, the apex and sides being perfectly free; at first it consists entirely of a firm fibrinous coagulum, no exudative matter entering into its composition at this period, though important changes subsequently occur with it. The importance of the internal coagulum as a temporary means of arresting hæmorrhage, though great, has, I think, been overestimated. It is not formed at all in certain states of the blood, when that fluid is devoid of plasticity; and in some cases the proximity of a collateral branch to the cut end of the vessel appears, by preventing the stagnation of the blood within it, to interfere with coagulation. Even when it is formed, it is of but little service, so far as the primary arrest of the hæmorrhage is concerned, not being deposited until after the flow of blood has been checked by other means, such as the deposit of the external coagulum and the contraction of the vessel. After it is formed, it is useful in acting as a damper, and in breaking the force of the wave of blood against the cut end of the vessel. It is in the permanent arrest of hæmorrhage that the internal coagulum is of great importance.

After the hæmorrhage from the cut artery has been arrested temporarily by the means that have been indicated, Nature proceeds to secure the vessel by permanently occluding it.

PERMANENT CLOSURE of a cut artery is effected by two processes:

1. Adhesion in the Vessel and in the Surrounding Parts.
2. Continued Contraction of the Artery.

1. **Adhesion.**—A few hours after the division of the artery, lymph is found to have been poured out both within and on the outside of the injured vessel. The lymph that is thrown out within the vessel forms the most important part of the internal coagulum, and tends materially to the permanent closure of the wound. It is effused from the cut surface of the internal and middle coats, around and immediately within the contracted orifice of the vessel, forming a small nodule projecting into its interior. If an internal clot have already formed, this plastic nodule is deposited underneath it, or is effused into its base; if no temporary clot have formed, a conical mass of coagulum will be deposited upon this nodule, in obedience to that law of pathology by which blood tends to coagulate upon inflamed points. When fully formed, this coagulum differs materially in structure at different points. At its base it is firm, of a brownish or buff color, and is composed principally of fibrine; above this it becomes dark maroon-colored, and ends in a long tail-like projection of simple clot, which extends up to the nearest large collateral branch. The important part of this coagulum, pathologically speaking, is its plastic base: the rest, however long it may be, is of no use in the permanent closure of the vessel; but, like the internal clot already described, merely serves to break the shock of the blood-stream.

Coincidently with these changes in the interior of the vessel, important phenomena occur on its exterior. Exudation takes place in the sheath and in the surrounding parts, a round or ovoid mass of lymph being formed, which is at first mixed up with the external coagulum; the coloring matter of this, however, gradually becomes absorbed, leaving the plastic material accumulated in a mass, and completely blocking up the end of the vessel from the outside.

2. **Contraction.**—Contemporaneously with these changes, and for some time afterwards, the artery goes on contracting, until it embraces the included coagulum so firmly as to appear adherent to every part of it, and some difficulty is experienced in separating them. That the coagulum and artery are not adherent I have ascertained by finding, on careful dissection, that the transverse striæ of the lining membrane of the artery are always visible, although the coats of the vessel are often stained nearly black by the imbibition of the coloring matter of the blood. The contracted vessel usually assumes a conical shape; but in some cases I have seen the contraction commence suddenly, the narrowed part being perfectly cylindrical for the distance of about an inch.

The changes that have just been described are those which take place in the proximal end of the artery. In the distal or inferior end, occlusion is effected by processes essentially the same, but the retraction and contraction of the vessel are not so complete and extensive, and the coagulum is usually smaller both inside and outside; in some cases, indeed, the internal coagulum is deficient. The less perfect closure of the distal end may, as Guthrie suggests, be the cause of the more frequent occurrence of hæmorrhage from it.

The ultimate change that takes place in the divided artery is the transformation of its cut extremity, up to the first collateral branch, into a dense fibro-cellular cord. This is effected by the plastic effusion

inside and outside the artery, with the cut and contracted vessel in the centre, developing into fibro-cellular tissue, which becomes vascularized and incorporated with the adjacent arterial walls.

Arrest of Hæmorrhage from a Punctured or Partially Divided Artery is effected in a somewhat different manner from what has been just now described; the difference consisting in the changes that go on in the neighborhood of the wound. If the wound in the soft parts covering the artery be of small size and oblique in direction, so that the blood does not escape with too great facility, it will be found that the temporary arrest of the hæmorrhage takes place by an extravasation of blood occurring between the artery and its sheath, by which the vessel is not only compressed, but the relations between the wound and the aperture in the sheath are altered. This stratum of coagulated blood extends for some distance within the sheath, above and below the wound, opposite to which it is thicker than elsewhere. Coagulum may likewise be formed in the tissues of the part outside the sheath, by which the vessel is still further compressed, and the tendency to the escape of blood proportionately lessened.

The permanent closure of the puncture is effected by adhesive processes. Lymph may be effused in such a way as to be sufficient merely to plug the wound in the coats; or it may obliterate the whole interior of the artery, producing complete occlusion of it. In order that the wound in the artery should unite simply by the formation of a cicatrix in the coats, without obliterating the cavity of the vessel, it is necessary that it be below a certain size; but this size will vary according to the direction of the wound. If this be longitudinal or slightly oblique, it will be more likely to unite in this way than if transverse. Guthrie states that, in an artery of the size of the temporal, a small longitudinal wound may sometimes heal without obliteration of the vessel, though this very rarely happens in larger arteries. If a large vessel, such as the femoral, be opened longitudinally to the extent of one-fourth of its circumference, there is no proof that the wound can heal without obliteration of the cavity of the artery; but when a longitudinal wound in a large artery is very small, little more than a puncture, closure may possibly take place simply by its cicatrization. The plastic matter forming the cicatrix is thrown out by the external coat of the artery. The internal and middle coats do not unite strongly, the aperture in them being merely filled up by a plug of lymph; hence the artery always continues weak at this point, and may eventually become aneurismal.

If an artery of the second or third magnitude, as the axillary or femoral, be divided to one-fourth or more of its circumference, either fatal hæmorrhage or the formation of a traumatic aneurism will take place, according to the size and more or less direct character of the external wound. In those comparatively rare cases, however, in which the hæmorrhage is arrested without these consequences ensuing, it will be found that it is so, by the vessel becoming obliterated by a plug of lymph, which is poured out at the wounded part and gradually encroaches on the cavity of the artery, until complete obliteration is produced, and the vessel at the seat of obstruction becomes converted into a fibro-cellular cord.

SURGICAL TREATMENT OF ARTERIAL HÆMORRHAGE.

The object of the Surgeon, in any means that he may adopt for the suppression of arterial hæmorrhage, should be to imitate, hasten, or assist the natural processes, or to excite analogous ones. All his means

act by one or other of the following methods:—1. By increasing the Retraction and Contraction of the arterial coats; 2. By forming an Artificial Coagulum; 3. By exciting Adhesive Exudation in and around the Vessel.

The danger from arterial hæmorrhage, and the measures that must be adopted to meet it, vary according to the size of the vessel. In all circumstances the Surgeon should bear in mind the excellent advice given by Guthrie, never to fear bleeding from any artery on which he can lay his finger, digital pressure readily controlling the bleeding from the largest vessels, provided it can be fairly applied; or the cut end of the artery may be seized between the finger and thumb. Thus, in amputation at the hip and shoulder-joints, the assistant readily controls the rush of blood from the femoral and axillary arteries by grasping them between his fingers. Above all, the Surgeon should never dread hæmorrhage, nor lose his presence of mind when it occurs. If recourse be had to proper means, it can always be at least temporarily arrested. And on no account should any one who pretends to the character of a Surgeon employ inefficient means to stop it, and imagine that he can, by covering up the wound with rags, handkerchiefs, &c., prevent the escape of blood. These procedures only hide the loss that is going on, and, by increasing the warmth of the parts, prevent the contraction of the vessels, and favor the continuance of the bleeding. Under all circumstances, therefore, bleeding wounds should be opened up, the coagula gently removed from their surface by means of a piece of soft sponge or a stream of cold water, and the part well cleaned. In this way "you look your enemy in the face," and can adopt efficient means for the permanent arrest of the hæmorrhage.

The flow of blood through a limb may be controlled for a *temporary* purpose, as during an operation, by one of three methods, viz., compression by the hand—by the elastic band—or by the tourniquet. The compression of the main artery by the hands of an assistant may be done in the lower extremity by pressing the femoral artery against the brim of the pubic bone, and in the upper extremity by compressing the subclavian against the first rib, or the brachial against the shaft of the humerus. The pressure should be made by grasping the limb with one hand in such a way that the thumb bears upon the artery, and presses it directly against the subjacent bone. If the limb be large, or if long-continued pressure be required, the thumb of the other hand should be firmly applied upon that which is already compressing the vessel (Fig. 5, page 60). In some cases, especially when the subclavian or external iliac requires to be compressed, the handle of a large key, or the end of a desk seal, covered with leather, will be found the most convenient instrument for applying the pressure.

In particular and exceptional instances, where the artery has become unusually deeply seated—as, for instance, where the clavicle has been pushed up above the subclavian by an aneurismal tumor—and when ordinary means fail in effecting a secure compression of the vessel, a very effectual mode of controlling the flow of blood through it has been adopted by Syme. This consists in making an incision through the skin and superficial fascia over the artery so that the fingers of the assistant may be brought to bear almost directly upon the vessel, which may thus be securely and effectually compressed.

The use of the elastic band, or Esmarch's bloodless method, has been described and figured at page 54.

In most cases, however, in which temporary compression of the artery

is required, the **Tourniquet** should be employed. It is far safer to trust to this instrument, than to the hands of an assistant, however steady and strong. When the tourniquet is applied with a sufficient degree of tightness, the whole circulation through the limb may be completely arrested. This can never be done by the compression of the main trunk alone, the collateral and minor vessels conveying blood into the limb independently of it. Then again, if the operation be unexpectedly protracted from any cause, the fingers of an assistant may tire or stiffen; and, the steadiness of their pressure becoming relaxed, hæmorrhage may ensue. For these reasons, Surgeons almost invariably employ the tourniquet in amputations; and even Liston, who at one period of his career discarded this instrument, commonly employed it during the latter years of his life. In applying the tourniquet, care should be taken not to screw it up until the very moment when the compression is required, and then to do so quickly and with considerable force, lest venous congestion of the limb take place, owing to the veins being compressed before the circulation in the arteries is arrested.

It is difficult to say how long complete arrest of the circulation through a limb may be maintained by the elastic band or the tourniquet without danger of gangrene. It must necessarily vary according to age. As a general rule, I should say that Esmarch's method might be used for about one hour, and the tourniquet for three hours with safety.

The different means that may be employed for the *permanent* arrest of hæmorrhage are, 1, the Application of Cold; 2, Styptics; 3, Cauterisation with the Hot Iron; 4, Pressure; 5, Flexion; 6, Torsion; 7, Ligature; and 8, Acupressure.

1. Application of Cold is sufficient to arrest the general oozing of arterial blood which is always observed on a cut surface. The mere exposure of a wound, which has bled freely so long as it has been covered up by pledgets and bandages, to the cold air, is often sufficient. When this does not succeed, the application of a piece of lint, soaked in cold water, will usually arrest the flow of blood. When it is necessary to do this speedily, as in some operations about the air-passages, a small stream of cold water may be allowed to drip into the wound, and thus cause rapid contraction of the vessels, and consequent cessation of bleeding. In cases of bleeding into some of the hollow cavities of the body, as the rectum, vagina, or mouth, the application of ice is advantageous. Its use should not, however, be too long continued, lest sloughing occur. Indeed, if cold do not speedily, almost at once, arrest the bleeding by constricting the vessels, it is better to have recourse to other and more efficient means.

2. Styptics aid powerfully the contraction of the vessels, and, by increasing the rapidity of formation and the firmness of the coagulum, tend to arrest the hæmorrhage; they are principally used in oozing from spongy parts, or in bleeding from cavities or organs to which other applications cannot readily be made. The great objection to their employment in some wounds consists in their tendency to modify injuriously the character of the surface, and to prevent union by the first intention. The most useful styptics are the solution of perchloride of iron, spirits of turpentine, gallic acid, and matico; the application of alum, or touching a bleeding part with a pointed stick of the nitrate of silver, is also serviceable. Of all these, the solution of the perchloride of iron, when injected into or applied upon a bleeding part, acts as the readiest and most efficient hæmostatic, coagulating the blood with remarkable rapidity, and into a very firm clot. In order to apply this or any other

styptic effectually, the part should be wiped dry, all coagula removed, and a piece of lint or cotton-wool, soaked in the solution and then squeezed nearly dry, firmly applied and maintained by the pressure either of the finger or of a pad and bandage. If the bleeding proceed from a mucous canal, this should be firmly plugged with the lint so prepared.

3. CAUTERISATION by means of the red-hot iron was almost the only mode of arresting arterial hæmorrhage that was known to the ancients. It is now comparatively seldom employed, but yet in many cases it is of the most unquestionable utility, and superior to any other means that we possess; more particularly in those cases in which the hæmorrhage proceeds from a soft and porous part that will not hold a ligature, or from the surface of which many points appear to be bleeding at the same time. A somewhat conical iron of sufficient size should be used, and the hæmorrhage will often be staid more effectually if it be applied at a black, than at a red or white heat. As the actual cautery blocks up the artery by a thick slough or eschar, there is always some danger of a recurrence of the bleeding when it separates, and the Surgeon must be on his guard about the sixth or eighth day lest the hæmorrhage break out afresh.

4. DIRECT PRESSURE upon the bleeding part is a very efficient mode of arresting hæmorrhage from small arteries. It is not, however, applicable to all parts of the body, as it is necessary that the vessel should have a bone subjacent to it, so as to afford a point of counterpressure; hence it cannot readily be employed in soft and movable parts, as the throat or perinæum. Pressure may be practised in various ways. Sometimes the mere uniform compression of a bandage is sufficient to arrest hæmorrhage; thus oozing from a wound may often be stopped by laying down the flaps, and applying a bandage rather tightly over them. Sometimes a weight applied upon this will tend still further to arrest the bleeding; as, for instance, by means of a shot or sand-bag laid upon the part. In the case of bleeding from hollow cavities, as the rectum, vagina, or nares, the hæmorrhage may be arrested by the pressure of a plug of sponge or lint, to which sometimes a styptic may advantageously be added. When the hæmorrhage proceeds from the puncture of a small or moderate-sized artery, as of the temporal or brachial, pressure should be made against the adjacent bone by means of a graduated compress and bandage, and should be continued until complete consolidation of the wound has taken place, the vessel becoming obliterated. The *graduated compress* should be at least an inch in thickness, and made of a series of pledgets of lint of a circular shape, gradually diminishing in size. It should be applied with its pointed end resting over the wound in the vessel. In applying it, care should be taken that the part on which the pressure is to be exercised has been thoroughly dried of all blood, and that the artery is commanded above the wound by a tourniquet, or by the pressure of an assistant's fingers. A thick slice of a phial-cork, or a fourpenny piece, wrapped in lint, being placed on the wound, the graduated compress should be bandaged tightly over the whole. When applied in this way, pressure acts by inducing adhesive inflammation and obliteration of the vessel at the point compressed.

5. FORCIBLE FLEXION, as a means of arresting hæmorrhage from the arteries of the limbs, has in recent years been advocated by Heath of Newcastle, Adelmann of Dorpat, and others. Its application is founded on the fact, specially pointed out in 1843 by Formey, that flexion of the arm at the elbow-joint weakens or arrests the pulsation at the wrist. Malgaigne, Vidal, Fleury, Fry, and some other Surgeons, have

reported cases in which the plan was employed successfully; but until lately the method has attracted little attention. Heath, from a number of experiments made by him in Newcastle Infirmary, has found that flexion of the arm at the elbow, or of the leg at the knee, diminishes or arrests the pulse in the distant arteries. In this respect he confirms the observations of Hyrtl and others; but he finds also that in the arm the process is greatly aided by placing a piece of lint or a handkerchief rolled up in the bend of the elbow; and in the lower limb, by bending the thigh on the abdomen at the same time that the leg is bent at the knee. Where flexion acts successfully as a means of hæmostasis—as it is reported to have done in several cases, especially in wounds of the palmar arteries and the vessels of the fore-arm—it probably does so by weaking the current of blood, so as to favor the closure of the arterial wound in the manner described in speaking of the Natural Arrest of Hæmorrhage. The apparent simplicity and safety (when carefully applied) of flexion render it worthy of further trial in cases of injury of the arteries of the fore-arm and hand or of the leg and foot. A roll of lint or other soft material having been placed in the flexure of the joint, the limb should be bent until it is perceived that the hæmorrhage is arrested, and should then be maintained in position by means of a handkerchief or bandage. Care must of course be taken not to exercise too great compression, by which gangrene might be produced. The flexion should be kept up till the Surgeon, by careful examination, is satisfied that there is no further risk of hæmorrhage.

6. Torsion of Cut Arteries for the arrest of hæmorrhage is mentioned by Galen; but the practice seems to have been forgotten until about 1828. It was revived in France by Amussat, Velpeau, and Thierry;

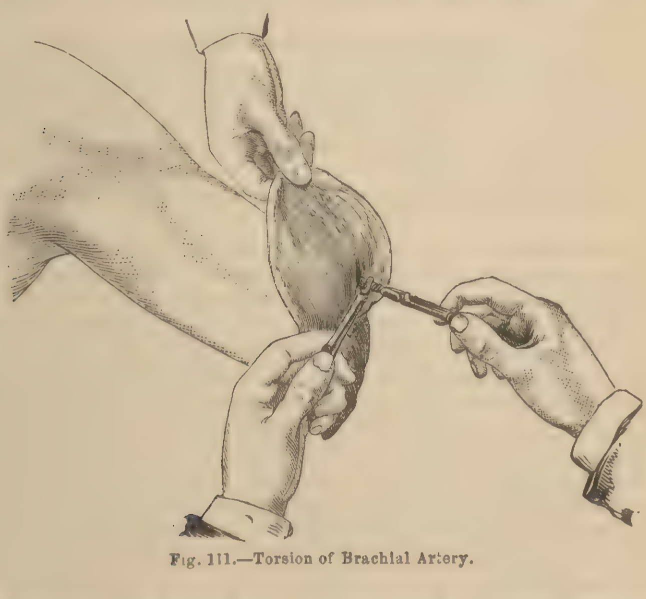


Fig. 111.—Torsion of Brachial Artery.

and in Germany by Fricke, who experimented upon and practised this method of treating divided arteries, with much ingenuity and perseverance. But, notwithstanding the efforts made to force it on the attention of Surgeons, it was gradually abandoned, even by its strongest

advocates. Torsion has never found much favor amongst Surgeons in this country, and, perhaps, been too much neglected. Of late years it has, however, again been revived, chiefly in connection with and by the advocates of the "Antiseptic Treatment," and by those who have been anxious to do away with the use of the ligature, as being injurious in many ways, and more especially in regard to the direct union of wounds, particularly in plastic and other similar operations where the presence of a ligature is very liable to occasion irritation and suppuration.

Torsion may be practised in various ways. Thus, Amussat recommends that the artery be drawn out for about half an inch by one pair of forceps; that it then be seized at its attached end with another forceps, and that the end be twisted off by about a dozen turns. Velpeau and Fricke advise that the end be not taken off, but merely twisted seven to eight times, according to the size of the vessel. Thierry simply seizes the artery and twists it in the direction of its axis. In seizing the artery it is peculiarly important, as Dupuytren has pointed out, that the whole vessel be grasped by the forceps, and that care be taken not to introduce one blade into the open end of the vessel, and thus only twist half of it. There can be no doubt that hæmorrhage from the largest vessels may be effectually stopped by torsion. Amussat and Velpeau repeatedly used it to close the femoral, brachial, ulnar, and radial arteries in amputation of the thigh, arm, and fore-arm.

In torsion an artery is placed in the condition of one that is lacerated or torn through. The internal and middle coats are retracted, and the external one is twisted into a kind of screw beyond them. A coagulum next forms within the vessel, blocking up its extremity; inflammation then takes place, gluing together the coats of the artery; the twisted end sloughs off, and the vessel becomes occluded up to the nearest collateral branch.

Torsion and Ligature Compared.—The employment of torsion as a substitute for the ligature is advocated on three grounds: 1, that, whilst equally safe, it is more easy of application; 2, that it is less liable to be followed by secondary hæmorrhage; and 3, that when an artery is closed by torsion, no foreign body is left in the wound that could interfere with its direct union.

Let us briefly examine these assumed advantages of torsion over the ligature.

1. So far as ease of application is concerned, there can be no doubt that the advantage is in favor of the ligature. This is especially and very markedly the case with small vessels and those that cannot be drawn out of the sheath. In the case of the larger arteries, that can be denuded and drawn out of the neighboring tissues, it is at least as easy to throw a thread round the exposed vessel as to twist it up securely.

2. With reference to the comparative freedom from secondary hæmorrhage, we have few data. This accident so rarely follows the use of the ligature in open wounds, that it is scarcely to be taken into account as a source of danger; and when it does occur, it arises from causes, such as a diseased state of the tissues and blood, that are equally independent of ligature and of torsion. And if secondary hæmorrhage rarely follows torsion of an artery, the same may be said with equal truth with respect to its ligature.

3. The torsion of arteries was strongly advocated on the ground that, whilst equally as safe as the ligature, there would after its employment be less liability to inflammation and suppuration, as no foreign body was left in the wound. This argument was especially used by Amussat, who

stated that, as the employment of torsion reduces the inflammation and suppuration of a wound almost to nothing, the cicatrisation must necessarily be more rapid. This statement, however, was not borne out by experience; and no difference was observable in that respect between the healing of wounds in which the vessels had been tied and those where they had been twisted. It was hence considered that the advantage assumed for torsion over the ligature in this respect was more fanciful than real; and Velpeau, who was one of its earliest and staunchest advocates, admitted, after a prolonged experience of it, that torsion was not applicable in every case, and that in none did it possess any real advantage over the ligature.

The question as to the injurious influence exercised by the ligature as a foreign body in the healing of wounds will be discussed when we come to compare the relative merits of acupressure and the ligature as a means of arresting hæmorrhage (p. 310). But the question as to whether, in employing torsion, we completely clear the wound of all foreign bodies and succeed in preventing the injurious interposition of a substance that is detrimental to the healing process, may be considered here. We must discuss this question according as torsion is applied to the larger or to the smaller arteries.

When a large artery, such as the femoral or brachial, is twisted for the arrest of hæmorrhage, it is drawn out of its sheath, the vascular connections with which are disturbed or broken through; the end that is twisted is severely pinched and bruised; the internal and middle coats are broken through and turned back, whilst the external one is screwed into a tight twist beyond these; and this, together with the turning back of the separated internal and middle coats, forms the obstacle to the escape of blood, the coagulum forming above this point exactly as in the case of a ligatured artery. Manec, in his classical work on the ligature of the arteries, wrote as follows. "The extremity of the twisted artery and the fragments of the internal and middle coats constitute a foreign body;—these parts of the vessel, being severely bruised by the torsion, maintain no connection with the surrounding tissues, are unable to form any adhesion to them, and can only be removed by the conjoined action of suppuration and absorption." Manec further states as the result of his experiments that, when he applied the ligature to the main artery of one limb and employed torsion upon the corresponding vessel of the other, he almost always found that the wound cicatrised more easily when the artery was tied than when it was twisted. Thus it would appear that the result of practical experience and of experiment tend to show that the twisted end of a large artery is in reality a foreign body; and that in this respect torsion, when applied to the principal arteries of a limb, presents no advantage over the ligature.

But the case is undoubtedly different with the smaller arteries. Here the vessel need not be drawn out or detached from surrounding parts; and consequently there is not the same injury inflicted upon its free end. The mere pinching and moderate twisting of the bleeding point will be sufficient to arrest the hæmorrhage from it. And in these cases, but in these only, torsion appears to me to possess a decided advantage over the ligature. This is more particularly the case when, as in plastic operations, direct union is of the first importance, and the presence of the knot and thread of the ligature would infallibly leave a suppurating track.

There is one condition of an artery that is an insuperable obstacle to the successful employment of torsion, viz., the calcification of its coats

In such cases, carbolised catgut or thick silken ligatures can alone be used with safety.

7. LIGATURE is the means to which Surgeons commonly have recourse for the arrest of hæmorrhage from wounded arteries.

The Ligature had been occasionally and partially employed by the later Roman Surgeons; but with the decline of Surgery during the dark ages it fell completely into disuse, giving way to such barbarous and inefficient modes of arresting the hæmorrhage as the employment of the actual cautery, the performance of operations with red-hot knives, or the application of boiling pitch, or of molten lead, to the bleeding and freshly cut surface. About the middle of the sixteenth century, it was revived or reinvented by that great luminary of the French school of Surgery, Ambroise Paré. But so slowly did the ligature make way, that Sharpe, Surgeon to Guy's Hospital, writing in 1761, two centuries after its re-introduction by Paré, found it necessary, in his well-known work, entitled, "A Critical Enquiry into the Present State of Surgery," formally to advocate its employment for the arrest of hemorrhage from wounded arteries, in preference to styptics or the cautery, on the ground that "it was not as yet universally practised amongst Surgeons residing in the more distant counties of our kingdom." What, it may be asked, was the reason that it took two centuries to promulgate the use of the simplest and most efficacious means we possess in surgery for the arrest of hæmorrhage—a simple tying up of a spouting artery—a means that no Surgeon could now for a day dispense with? The reason simply was, that Surgeons were totally ignorant of the means employed by Nature for the occlusion of arteries; that they consequently did not know how to apply a ligature to these vessels, or what kind of ligature should be used; and that, in their anxiety to avoid the recurrence of secondary hæmorrhage, and to make all safe, they fell into the very errors they would have endeavored to avoid, had they been acquainted with the physiology of the processes by which Nature accomplishes the closure of the artery and the separation of the thread.

Between twenty and thirty years after the time at which Sharpe wrote, Hunter introduced that great improvement in the surgical treatment of aneurism—the deligation of the artery at a distance from the sac, and in a healthy part of its course; but this great accession to the treatment of a most formidable disease was but coldly received, and ran some risk of being lost to the world in consequence of the ill-success that attended the earlier operations. In Hunter's first operation, four ligatures were used, all of which were applied so slackly as merely to compress the artery for some distance, in order to avoid too great a degree of pressure at any one point; the artery was denuded, so that a spatula could be passed under it. Although in his subsequent operations Hunter contented himself with employing but one ligature, yet sometimes the vein was included in this; and he did not draw the noose tight for fear of injuring the coats of the vessel, in accordance with the doctrine of the day—Surgeons generally at this time being haunted with the dread of injuring, and thereby weakening, the coats of the artery; and, in order to avoid doing so, they adopted modes of treatment that almost infallibly led to ulceration of the vessels and consecutive hæmorrhage. The application of several ligatures of reserve, applied slack—the use of broad tapes—the interposition of plugs of cork, wood, agaric, or lead, or of rolls of lint or plaster, between the thread and the vessel, were some amongst the plans that were in common use. And how can we be surprised that the patients perished of hæmorrhage, and that ligature of the

vessel was nearly as inefficient and fatal a means of arresting bleeding as the use of a cautery, or of a button of white vitriol?

Jones, by an appeal to experiment, and by means of a series of admirably conducted investigations on living animals, showed that the very point which Surgeons were anxious to avoid—the division of the coats of the vessel by the tightening of the noose—was that on which the patient's safety depended; he also pointed out the form and size of ligature that was most safe, the degree of force with which it should be applied, and the processes adopted by nature for the occlusion of the vessel. Thus a more rational practice was introduced, and then for the first time Surgeons had full confidence in the use of the ligature.

Principles of Treatment of Wounded Arteries by Ligature.—The whole of the doctrine of the general treatment of wounded arteries by ligature may be included in two great principles: 1. *To cut directly down on the wounded part, and to tie the vessel there;* and 2. *To apply a ligature to both ends, if it be completely divided, or to the distal as well as the proximal side of the wound, if it be merely punctured.*

These principles of treatment were distinctly laid down by John Bell;[1] but, although this great Surgeon inculcated forcibly these rules of practice, Surgeons appear to have been led away by the erroneous idea of applying the Hunterian principles in the treatment of aneurism to that of wounded arteries, until Guthrie, by his practice and precepts, and by adducing an overwhelming mass of proof to bear on this important question, recalled the attention of the Profession to the proper and rational treatment of wounded arteries.

1. The principal reason in favor of *cutting down directly upon the wounded part of the vessel* is, that the ligature of the main trunk at a distance above it only stops the direct supply of blood to the limb, but does not interfere with the indirect or anastomosing circulation, by which means the blood readily passes into that portion of the vessel which is beyond the ligature, and continues to escape from the distal aperture of the wound. Thus, though bright arterial blood may no longer jet from the upper part of the wound, blood which has become of a dark color in consequence of the changes to which it is subjected in its passage through the vascular network of the limb, will continue to well out from the lower aperture in the artery, entailing the necessity of further operative interference to restrain its flow; and, unless this be done, the patient will die of hæmorrhage as surely, though perhaps not quite so speedily, as if no ligature had been applied. Thus, if a Surgeon endeavor to arrest the flow of blood from a wound of the ulnar artery near the palm by ligaturing the brachial in the middle of the arm, and, when the blood bursts forth as furiously as ever, apply successive ligatures to the arteries of the foramen with as little success; he will at last, on account of the continued recurrence of hæmorrhage, be forced to adopt the simple expedient that ought to have been had recourse to in the first instance, namely, ligaturing the vessel at the point wounded.

Another reason for the practice now advocated is, that in some cases the Surgeon cannot possibly know what artery is injured unless he seek for it in the wound itself. A large artery may, from the direction of the stab and the impetuous flow of blood that has followed it, appear to be wounded, when in reality it is only a minor branch that has been injured. Thus, for instance, in hæmorrhage from a stab in the axilla, which proved fatal, notwithstanding the ligature of the subclavian artery,

[1] "Principles of Surgery," vol. i., pp. 350, 390, 8vo. edit.

for supposed wound of the axillary, the long thoracic was found to be the vessel divided; so also the external iliac artery has been ligatured for supposed wound of the common femoral, when in reality it was the external pudic that was injured.

The rule of cutting down on the injured part of the artery applies to all cases in which the wound is still open, whatever be its condition. However deep, inflamed, and sloughy the wound; however ill-conditioned and infiltrated with pus or blood the neighboring parts may be, it may be stated as a general rule, to which, however, there are some exceptions, especially in wounds of the palmar arch, or of the secondary branches of the carotid, that there is no safety to the patient unless the artery be cut down upon and tied at the part injured. This must always be done at any period after the receipt of the injury, so long as there is an external wound communicating with the artery. An operation of this kind is often attended with the greatest possible difficulty, not only owing to the hæmorrhage that usually accompanies it and obscures the parts, but also in consequence of the inflamed, infiltrated, and sloughy condition of the tissues in the wound. In order to moderate the hæmorrhage, the pressure of an assistant's finger on the artery high up in the limb must not be trusted to; but a tourniquet should be applied so as completely to arrest the circulation through the limb, and thus to facilitate the discovery and exposure of the injured vessel, the wound being dry. The application of an elastic bandage, such as that recommended by Esmarch, may be used with advantage to exsanguinate a limb, in which an artery has been wounded. By means of this excellent device the divided vessel may be safely cut down upon and dissected out as readily as in the dead body. A large probe should then be passed to the bottom of the wound; and, taking this as the centre, a free incision should be made in such a direction as may best lay open the cavity with the least injury to the muscles and other soft parts. After turning out any coagula contained in the wound, and clearing it as well as possible, the injured vessel must be sought for. The situation of this may sometimes be ascertained at once by the gaping of the cut in its coats. In many cases, however, it is necessary to relax the pressure upon the artery, so as to allow a jet of blood to escape, and thus indicate the position of the aperture. The ligature may then be applied by passing an aneurism-needle under the vessel, if it be partially divided; or, if it be completely cut across, by drawing forwards the end and ligaturing it, as in an open wound. In doing this, care must be taken that the ligature be really applied to the vessel, and that a portion of the sheath infiltrated with blood, or thickened by adherent coagulum, be not mistaken for the artery. In applying the ligature under the circumstances here indicated, viz., in a wound that is sloughy and suppurating, the tissues will necessarily in a great degree have lost their cohesion and firmness; and although the arterial tissue resists the disorganising influence of low inflammatory action much longer than areolar or muscular tissue, yet it will also have become softened and less resistant. Hence the vessel must be isolated with gentleness and care, and the ligature very carefully tied—no undue force being used. The ligature will usually separate in such cases several days before the ordinary time. The incisions down to the wounded artery should generally be made on the side of the wound in the vessel, and through the wound in the soft tissues covering it. Guthrie, however, advises that, in those cases in which the wound passes indirectly to the principal artery from the back or outside of the limb, the Surgeon need not follow the track of the

wound, but may cut down on the vessel where it lies nearest the surface; then, on passing a probe through the wound, the spot at which the artery has probably been injured will be pointed out, and the ligature must then be applied in the way usual in cases of primary hæmorrhage.

In *primary* hæmorrhage from wound of an artery, no operation should be undertaken unless the bleeding be actually continuing. If the bleeding have been arrested, however furious it may have been, the Surgeon should never, unless it burst forth again, search for the wounded vessel, nor undertake any operation. A man was brought to the University College Hospital with a deep stab in the groin, directly in the course of the external iliac artery; a very large quantity of arterial blood had been lost, but the hæmorrhage was arrested on his admission by the application of pressure, &c. From the great and sudden loss of blood it was supposed that the external iliac had been punctured, but it was not thought advisable to perform any operation unless hæmorrhage recurred. The bleeding did not return, the wound healing without any further trouble. In *secondary* hæmorrhage the case is different. There the Surgeon must be prepared to secure the vessel, even though the bleeding have for the time ceased.

2. The second great principle in the treatment of wounded arteries is, that the *ligature is to be applied to both ends of the vessel, if it be completely cut across; or on both sides of the aperture in it, if it be only partially divided.*

The reason for this rule of practice is founded on physiological grounds as well as on practical experience. If the anastomoses of the part be very free, as in the arteries of the palm or fore-arm, bleeding may continue from the distal end, uninterrupted by the ligature on the proximal side of the wound. If they be less free, it will probably issue in a stream of dark-looking venous blood in the course of two or three days. After the collateral circulation has been sufficiently established, bright scarlet blood will burst forth from the distal aperture. Experience has shown that it is in this way that secondary hæmorrhage from wounded arteries commonly occurs, the bleeding coming from the distal and not from the proximal end of the vessel.

In some cases the distal end is so retracted and covered in by surrounding parts, that it cannot be found in order to be ligated. In these circumstances, the best effect has resulted from plugging the wound from the bottom with a graduated sponge-compress. If an arterial branch happen to be divided so close to its origin that it cannot be secured, the case must be treated as one of puncture of the main trunk, which must be ligated above and below the bleeding orifice.

Although advocating strongly the importance of the distal as well as the proximal ligature in all cases of wounded artery, I am aware that instances are on record in which the proximal ligature alone, even at a distance from the wound, has proved successful in arresting the hæmorrhage; but I cannot but regard those cases as accidentally successful, the distal end having been better plugged than usual with coagulum; and I am strongly of opinion that the rule of practice should be that which is laid down by John Bell, and forcibly illustrated by Guthrie, viz.:—That both ends of a wounded artery be sought for, and tied in the wound itself.

Application of the Ligature.—The mode of application of the ligature, and the kind of ligature to be used, vary according as, 1, the cut end of the artery has to be tied in an open wound, or as, 2, the vessel has to be secured in its continuity.

1. When the *divided vessel in an open wound* has to be tied, as after an amputation, the mouth of the artery must be seized and drawn forwards (Fig. 112). For this purpose a tenaculum, or sharp hook, is frequently used, and in many cases answers the purpose exceedingly well. There are, however, some objections to this instrument; thus, it occasionally seizes other tissues with the artery, and, as it draws the vessel forwards by perforating its coats, it has happened that, an accidental puncture having been made by it behind the part to which the ligature is applied, ulceration of the vessel and subsequent fatal hæmorrhage have ensued, as I have seen in one case. The most convenient instrument for the purpose of drawing forward the artery, and one to which no objection whatever applies, is Liston's "bull-dog" forceps. These have been conveniently modified by having the blades expanded just above the points (Fig. 113), so that the ligature can be slipped over the end of an artery that is deeply seated as between bones or close to the interosseous membrane of the leg—a situation in which it is sometimes troublesome to tie a vessel by any other means. In some cases the bleeding point may be so situated, that the ligature is most conveniently passed under and round it by means of an ordinary curved needle.

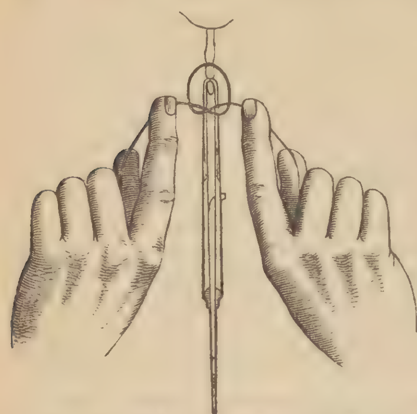


Fig. 112.—End of Artery drawn forwards. Application of Ligature.

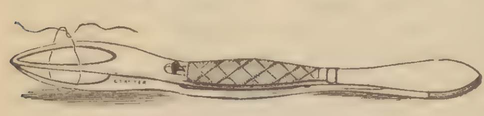


Fig. 113.—Liston's "Bull-dog" Forceps, modified.

The **kind of ligature** used must vary according to the size of the vessel. If this be small, fine round twine; if large, dentist's silk, or compressed smooth whipcord, should be employed. The latter should always be used in ligaturing the main artery of a limb. Before being used, the material should be well waxed, so that it may not be too limp; its strength should be tested by knotting it with a jerk, and, if found efficient, it may be cut up for use in pieces eighteen inches in length. In applying the ligature, care must be taken that it be put well over the cut end of the artery, that it clear the points of the forceps, and that it be tied tightly in a knot, which does not slip (Fig. 114). One end of the ligature should then be cut off about a quarter of an inch from the knot, and the other left hanging out of the wound. The ligature that secures the main artery should have both ends knotted together, by way of a distinctive mark. It is better to leave one end of the ligature; if both be cut off, the noose and knot left are apt to become enveloped by granulations, and, after the healing process is well advanced, or perhaps completed, to give rise to suppuration in and re-opening of the wound. The ligature that hangs

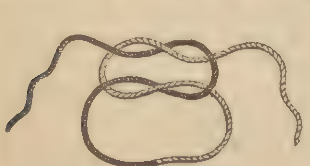


Fig. 114.—The Ligature-knot.

out of the wound acts as a seton, giving rise to a track of suppuration along its course, along which the secretions of the wound may drain away. The end of the artery which is included in the noose, and which projects beyond it, sloughs, and thus acts as a foreign body in the wound. When the artery that is tied is small, the end disintegrates and breaks down in the discharges; when it is large, it separates, often attached to the noose of the ligature when that has ulcerated through the portion of the vessel that has been tied, coming away with the ligature through the unhealed ligature-track. These inconveniences are inseparable from the use of the ligature, but may be materially lessened by the Surgeon bringing the threads out at the lower angle of the wound, and thus allowing the discharges to escape at the most dependent part.

2. When the artery has to be ligatured *in its continuity*, but at the point wounded, it must be exposed by as careful a dissection as the state of the parts will admit. If a Surgeon determine to apply a ligature at a distance from the injury, his anatomical knowledge will guide him to the vessel. This is usually done by cutting through the tissues in the course of the vessel; Hargrave, however, recommends that, in ligaturing arteries, the incisions should not be made parallel to the course of the vessel, but in an oblique or transverse direction over it; and this suggestion appears to me to be deserving of attention in some situations, more particularly in the ligature of the brachial at the bend of the arm, or of the carotid at the root of the neck. The Surgeon is usually guided to the vessel by some fixed line or point, as the edge of a muscle, which has a determined and constant relation to the artery. Thus, in exposing the brachial, he cuts along the inner border of the biceps. In some cases, however, as in the ligature of the iliac arteries, no such certain anatomical guide exists, and then an imaginary line is drawn between two fixed points—as the umbilicus and the centre of Poupart's ligament—which becomes the guide to the course of the vessel. These "directing lines" should be carefully studied and kept in mind.

In making the first incision, the skin should be put on the stretch by the fingers of the left hand, or by those of an assistant. If the artery be superficial, or if there be parts of importance in its vicinity, the incision should not penetrate deeper than the skin. But if the vessel be deeply seated and no parts of importance intervene, it may be carried at once through the subcutaneous areolar tissue, until the fascia covering the artery is exposed. This must then be pinched up with the forceps, and opened by the edge of the scalpel laid horizontally. Through this opening a grooved director may then be passed, and the fascia incised on it, without risk to subjacent parts. The sheath of the vessel is now exposed by a little careful dissection; and the next step of the operation, which consists in exposing the artery and separating it from its accompanying vein, is one of great

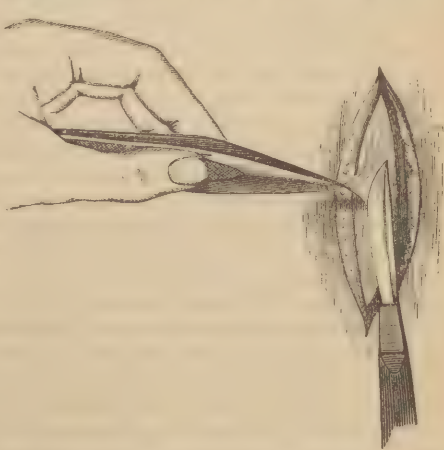


Fig. 115.—Exposure and Opening of the Sheath.

delicacy. This is done by pinching up the sheath with the forceps and applying the knife horizontally (Fig. 115). The point should never be used, nor the blade turned downwards against the artery, as an incautious movement or the mere pulsation of the vessel might cause it to be wounded. The artery having thus been exposed, the Surgeon seizes one edge of the sheath with the forceps, and, putting it on the stretch, proceeds to clean the artery, gently separating it from its accompanying vein by teazing through the areolar connections with a director; being careful not to expose it to a greater extent than is absolutely necessary for the passage of the ligature, lest subsequent sloughing of the vessel ensue, as a consequence of the destruction of the vascular connections between it and the sheath (Fig. 116), but at the same time being careful to clean thoroughly the part to be tied.

In opening the sheath, care must be taken not to wound any small branch, lest the collateral supply be interfered with, and danger of secondary hæmorrhage induced. The edge in the opening of the sheath being held tightly in the forceps so as to be rendered tense (Fig. 117), the ligature should then be carefully passed between the vein and

Fig. 116.—Opening in the Sheath: Vessels exposed.

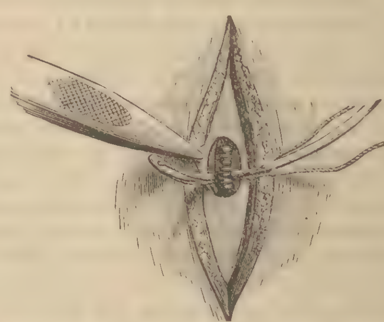


Fig. 117.—Passage of the Needle and Ligature.

artery, care being taken to include only the latter, and especially not to transfix and include a portion of the vein; an accident that often terminates fatally by phlebitis or gangrene. So also the Surgeon must be on his guard not to mistake any contiguous nerve for the artery, as has happened to the most experienced operators; and also to avoid transfixion and tying a portion of the thickened sheath instead of the vessel, as I have known happen to a most excellent Surgeon.

The *Tying of the Artery* and the consequent *Division of the Internal and Middle Coats* should be done evenly, smoothly, and completely, so as to leave a wound that readily takes on the adhesive inflammation. This is best done by a small round ligature, applied with such a degree of force that the Surgeon feels the inner and middle coats give away under his finger. Thus a *subcutaneous* section, as it were, is effected; and this, like all similar wounds, takes on adhesive action. The adhesion between the coats is much facilitated by the pressure of the ligature, which acts as a support to the vessel.

The best *material for ligature*, when applied to the continuity of an artery, is dentist's silk, compressed whipcord, well waxed, or carbolised catgut, tied in a knot, as represented in Fig. 114. Much ingenuity has been expended in devising instruments for passing the ligature under

the artery. In the majority of cases the common aneurism-needle—well ground down, but rounded at its extremity—is all that is required. Occasionally it may be advantageous to use a needle with a small curve. Many ingenious contrivances have been devised by Trant, Weiss, Coxeter, and others, for seizing and drawing forward the noose from the bottom of the wound. After the ligature has been passed under the vessel it should be tied tightly with a reef-knot, and both its ends left hanging out of the wound. The limb should then be elevated and be lightly covered with a piece of flannel, or cotton-wadding; care being taken not to apply pressure of any kind.

Modifications of the Ligature.—With the view of diminishing or removing the various inconveniences, real or supposed, that result from the use of the ligature, and especially with the object of promoting union of the wound by the first intention, four methods have been employed by Surgeons:—1, The use of Temporary Ligatures; 2, Cutting the Ends off close to the Kots; 3, The use of Wire to tie the artery; and 4, The employment of materials for the Ligature that might be Absorbed in the Wound.

1. The use of the **Temporary Ligature** in one of its modifications has already been attended to. This subject fully occupied the attention of Surgeons in this country nearly half a century ago, and has now in a great measure become matter of history, for the study of which I must refer to the writings of Jones, Travers, Velpeau, and others. I may, however, state, that the general result of the experiments made and the experience derived on this subject, is the following.

Jones found that, on cutting through the internal and middle coats of the carotid artery of a horse at three or four different points, with as many ligatures, and then *immediately* removing them, an effusion of lymph occurred by which the artery was plugged up.

These observations were not confirmed by other experiments, such as Hodgson, Travers, and Dalrymple.

But Travers found that, if the ligature were left in for several hours, or even for one hour, and then removed, obliteration of the artery ensued.

Roberts applied a ligature to the femoral artery for popliteal aneurism, and, on removing it after 24 hours, found the artery closed; and Travers ligatured the brachial artery of a man, and, on removing the ligature at the end of 50 hours, obtained an equally successful result. Their example was followed by Scarpa and Paletta.

Notwithstanding these favorable results, the failure of the method in the hands of Astley Cooper, Hutchinson, Beclard, and of Travers himself, and the observation of Vacca, that, if the ligature be left on the artery long enough to cause its obliteration, the section of the vessel is affected sooner or later, caused the use of the temporary ligature to be discontinued in surgical practice, even by those who at one time had most strongly advocated it.

2. The practice of **Cutting off the Ends of the Ligature** close to the knot, has been adopted by many Surgeons in the hope that it might either be absorbed, or, at least, that the irritation of the wound resulting from the dependent threads might be prevented. This practice was at one time much advocated by Lawrence; but, though employed by him at St. Bartholomew's Hospital in many cases of amputation, excision of the breast, and removal of the testicles, it was relinquished by him for more than thirty years before his death. He found that the noose and knot of the finest silk thread, such as is used for fish-lines, did not weigh more than the one-fortieth of a grain, when cut close to the vessel.

But, although some success attended the earlier use of the method, it was soon found that even this small quantity, together with the tied end of the vessel, set up irritation, gave rise to abscess, and was injurious: hence its abandonment in all cases in which the wound is closed with the view to speedy union. When the wound is left open to granulate, Surgeons commonly adopt this plan of treatment.

3. The use of **Wire Ligatures** is altogether of American origin. It originated with Physick and Levert of Alabama, who performed several experiments with threads of gold, silver, platinum, and lead. They found that with these the arteries of animals could be successfully tied, and that, the material of the ligature being unirritating, no evil from suppuration ensued. When the ends of the ligature were cut off close to the vessel, it was found that the small metallic noose became embedded in a cellular capsule. For some reason, this means fell into disuse, until it was revived by Marion Sims. At his suggestion I tried it in several cases of amputation and other surgical operations, but have long since abandoned it, as I found great inconveniences resulting from its use. If the ends of the wire were left out of the wound, the noose became embedded in a mass of plastic matter, did not separate, and, after several weeks, required considerable force to detach and disconnect it. If the ends were cut short, the sides of the wound healed over them; they became encapsuled, but were by no means innocuous; in some cases giving rise to severe neuralgia of the stump by pressure on and irritation of neighboring nerves; in others, after some weeks, causing localized circumscribed abscesses to form.

4. The employment of **Ligatures made of Materials that admit of Absorption** in the wound has been a favorite idea with many Surgeons, and is one in which much experimental ingenuity has at various times been expended: for the idea is a captivating one, and if it could be safely, certainly, and successfully carried out in practice, it would undoubtedly remove one of the obstacles to the union of wounds by direct adhesion. With this view, it was proposed to substitute ligatures made of animal substances for the ordinary threads made of hemp. Silk thread was used by Lawrence in 1815, and at first with success, union of the wound taking place in four to six days, without suppuration. But other Surgeons failed in this, and Lawrence himself was soon compelled to give it up from want of good results in his subsequent cases. Wardrop substituted the gut of the silk-worm made into fine cord, but with equally unsatisfactory results.

Catgut was used by Sir Astley Cooper as a material that was more likely to dissolve or to be absorbed than silk in any shape. The first cases in which it was employed as a ligature were full of promise. In one, a patient aged eighty, the wound healed in four days, and in another in twenty, and in neither did the noose of the ligature re-appear. Whether it was absorbed or encapsuled does not clearly appear. But other Surgeons failed to imitate this success; the catgut was found to be too weak, and the distinguished author of the practice could not himself maintain his first success with it, and eventually fell back on the ordinary hempen thread.

Strips of deer-skin were used by Jameson, of Philadelphia, and other American Surgeons about the same time, probably in 1814, before Lawrence's or Cooper's experiments. They were found to answer better than either silk or catgut, being stronger, more elastic, and more readily soluble. These, however, also fell into disuse, for what reason does not clearly appear.

The idea of the employment of ligatures made of animal substances, that would admit of absorption, and thus allow the wound to be immediately closed over the noose, so as in fact not to act as foreign bodies in the wound or as agents of suppuration, still occasionally presented itself to the minds of Surgeons; and, amongst others, Velpeau speaks of it with favor, admitting, however, that their precise nature and form have to be determined. Of late the use of catgut has been revived by Lister, in connection with his "Antiseptic Method" of dressing wounds. He uses the catgut soaked in carbolised oil, and has reported favorably of its employment.

Experience has fully proved the value of this material in the arrest of hæmorrhage, and a case has been reported by Holmes which shows that by its use it is possible completely to occlude a vessel of the size of the subclavian without division of its external coat. But very few cases of accident following its use have been reported. In one the ligature, which had been applied to the carotid artery, softened and yielded soon after its application; and in the other ulceration occurred in the coats of the femoral artery at the seat of ligature, and fatal secondary hæmorrhage took place. In the first case, there is reason to believe the ligature was not properly prepared; and in the second, the accident would probably have happened in the same way if a hemp or silk ligature had been used. The ligature is far more likely to soften when immersed in decomposing discharges than when buried in healthy granulations; but, even where no antiseptic dressing is adopted, it has been found to hold sufficiently long to ensure the obliteration of the vessel. At University College Hospital it has been used on arteries of all sizes from the femoral downwards, and in no case has any unpleasant consequence resulted from its employment. If further experience confirm these statements, we shall have reached as near perfection as possible in the arrest of hæmorrhage; as the catgut ligature combines many of the advantages of ligature, acupressure, and torsion, and has none of their dangers or inconveniences.

The preparation of the carbolised catgut is of the greatest importance. If soaked in pure carbolised oil, it becomes soft and slippery; it is difficult to tie and insecure when tied. Lister's direction for its preparation are as follows: "It must be suspended for some weeks in an emulsion of water, carbolic acid and oil, in which, after growing soft and opaque during the first few days, it gradually experiences an opposite change, and at length becomes again quite transparent, and is then little affected by water, and holds better when tied than waxed silk. The emulsion is best made by mixing one part of crystallised carbolic acid, deliquesced by means of water, with five parts of olive-oil. The very fine emulsion that results is placed in a covered jar, having a partition of glass or other material supported by pebbles at a short distance above the bottom, to afford space for the water that slowly subsides to accumulate in and keep it from coming into contact with the hanks of gut which are placed loosely in the upper part of the vessel. The process of preparation goes on best in a cool place, and should be continued for two months at least; and the gut goes on improving for an unlimited time if retained in the same oil."

Other modifications of the method of applying the ligature have been devised by Surgeons, in order to prevent the dangerous and troublesome consequences arising from the suppuration occasioned by it. Some, instead of bringing the ends out of the wound, after having tied the various arteries in the usual way, cut off one end of each ligature, and then draw the remaining one out through a separate puncture in the skin. Other

Surgeons, again, have contented themselves with simply passing the ligature around the artery, raising the vessel in the loop of the thread, which is not tied, and bringing both ends out through a puncture made in the skin, where they are firmly fixed, so that the vessel is compressed by the loop, not tied in it. The ligature is then withdrawn, at the expiration of two or three days.

These methods appear to me to have little to recommend them. The first complicates rather than simplifies the operation; and, at each ligatured point, a tendency to ulceration might easily be established The second method has the disadvantage of being unsafe. If the loop be drawn up tightly, it will cut through the vessel as if it had been tied. If it be left slack, there will certainly be a tendency to secondary hemorrhage.

Effects of Ligature.—The immediate effects on an artery of the application of a silk or thread ligature with a proper degree of force, are the division of the internal and middle coats of the vessel, and the constriction of its outer one. If we examine the ligatured vessel a few days after it has been tied, we find that the coats are contracted; that there is an internal pyramidal coagulum, composed of plastic matter at its base, and fibrinous clot towards its apex (Fig. 118); and that the ligatured portion of the vessel is surrounded by a quantity of lymph. If the artery be examined at a still later period than this—at the end of two or three months, for instance—it will be found to be converted into a fibro-cellular cord as high as the first collateral branch above the ligature (Fig. 128). Now these appearances are analogous to those met with in an artery that has been cut across and occluded without the application of a ligature; and are evidently the result of so-called adhesive inflammation of the vessel. The question arises, how this inflammation is set up when a ligature is applied. Is it by the pressure of the noose, or by the division of the coats of the artery? That it is not the mere pressure of the ligature that excites the occluding inflammation, is evident from the experiments of Jones and of Travers, who found that, if the ligature were removed shortly after its application, sufficient inflammatory action had been excited in the coats of the artery to lead to its complete occlusion. And though any inflammation set up in the external coat may cause an effusion of lymph inside the vessel, yet that which is required to repair the breach occasioned by the division of the internal and middle coats, is the principal source of the plastic deposit. The changes that take place in the vessel after the application of a ligature require, however, to be more carefully studied.

Fig. 118.—Femoral Artery, fifty six hours after Amputation.

The **Formation of the Internal Coagulum** in the proximal end is the most important part of the process. For the first four-and-twenty hours after the application of the ligature there is little, if any, appearance of this. Usually about this time, if opportunity offer to examine an artery in the human subject, it will be found that a small nodule of lymph, of a yellowish or buff color, has been deposited in the bottom of the cul-de-sac that is formed by the retraction and contraction of the cut ends of the inner and middle coats, so as to close up the extremity of the artery. About the second or third day, this coagulum will be found to have assumed a conical shape (Fig. 118), the base being made up of decolorised fibrine and exudation-matter, firmly adherent to the lower end of the artery; the mid-

dle and terminal portions of the coagulum, comprised of fibrinous clot, and of a dark purple or maroon color, lie loose and floating in the artery, extending up as high as the first collateral branch. About the tenth day, the end of the vessel will be found to be tightly and firmly contracted upon the enclosed plug (Fig. 119), the dark-colored portions of which now begin to undergo a process of absorption. Between this period and the sixth week, the contraction of the vessel and the absorption of the free part of the plug go on simultaneously; the shrunken clot becoming permeated with new blood-vessels, which communicate with the vasa vasorum, while the interior of the artery becomes darkly stained by imbibition of the coloring matter of the coagulum (Fig. 120). Lastly, the plastic base of the plug becomes incorporated with the contiguous arterial coats, and undergoes eventual transformation into fibro-cellular tissue.

Fig. 119.—Brachial Artery, ten days after Amputation.

Fig. 120.—Femoral Artery, six weeks after Amputation.

In some cases (Fig 121), there is an imperfect formation of the internal plug, or even total absence of it, and not unfrequently secondary hæmorrhage occurs as a consequence. This condition may arise either from want of plasticity in the blood, from an absence of due adhesive action, or from the coats not having been properly cut through. In other cases, in consequence of suppurative action being set up in the artery, a kind of disintegration or liquefaction of the plug takes place after it has been formed. This I have seen happen in a case of ligature of the carotid artery, in which death occurred from visceral disease ten weeks after the operation; and in the femoral, in cases of pyæmia (Fig. 122). In the distal cul-de-sac of the ligatured artery I have never seen any very distinct coagulum formed, either in the human subject or in dogs on which I have experimented, but merely small detached fragments of coagula and some plastic material.

Fig. 121.—Partial Absorption of Coagulum in Femoral, fourteen days after Amputation.

Fig. 122.—Femoral Arteries, ten days after Amputation of Thigh. Death from Pyæmia.

The changes that take place in the **External coat** are most important. After the internal and middle coats have been cut through by the ligature, the external coat would not be able to resist the impulse of the blood, were it not strengthened and consolidated by the adhesive process. The necessary stimulation is occasioned partly by the dissection required to expose the vessel, and partly by the pressure and irritation of the ligature. Lymph is thrown out between the vessel and its sheath, matting to-

gether these parts, and often enveloping the noose and knot in an ovoid mass. Progressively with the effusion of lymph and consequent strengthening of the coats, the pressure of the noose causes gradual sloughing and ulceration of the part included within it. The mode in which the noose ulcerates through the external coat is of much importance, as on this depends in a great measure the success of the ligature.

There are two sources of danger in connection with this process; either the sloughing may be too extensive, or the ulceration through the artery may take place before the adhesive plug is properly and finely formed. The chance of the sloughing being too extensive, principally arises from the artery being isolated and separated from its sheath to too great an extent during the dissection required to expose it, and its nutrient vessels being consequently divided in great numbers, so as to deprive that portion of the coats of the vessel of its vascular supply; hence the danger of passing a spatula, large probe, or the handle of a scalpel under the artery, and also of applying several ligatures. Premature ulceration of the vessel may occur, either from the patient's constitution being too debilitated to allow healthy reparative action, or from excessive degeneration of the artery at the point ligatured.

So soon as the ligature has ulcerated through that portion of the artery which is included in its noose, it becomes loosened and separates; frequently being thrown off with the discharges, or becoming detached on the slightest traction. The period of the separation of the ligature depends upon the size of the artery and the thickness of its coats. From the radial or ulnar arteries, it is usually detached by the eighth day; from the femoral, iliac, or subclavian, about the sixteenth or twentieth day. In some cases the ligature will continue attached for a much longer period than this, owing to the inclusion within its noose of a bit of fascia, nerve, or muscular substance. In order to hasten the separation in these cases, moderate traction and occasional twisting of the ligature may be practised.

8. Acupressure.—By Acupressure is meant the occlusion of an artery by the pressure of a needle in such a way as to arrest the circulation through it or the hemorrhage from it. This method of treatment was introduced into surgical practice by the late Sir James Simpson as a substitute for the ligature. Acupressure may be applied in several different ways. There are four principal methods.

The *first method* is carried on in the following way, which I give as nearly as possible in Sir James Simpson's own words. The Surgeon places the tip of the fore-finger of his left hand upon the bleeding mouth of the artery which he intends to compress and close; holding the needle in his right hand, he passes it through the cutaneous surface of the flap, and pushes it inwards till its point projects out to the extent of a few lines on the raw surface of the wound, a little to the right of, and anterior to, his finger-tip; he then, by the action of his right hand upon the head of the needle, turns and directs its sharp extremity so that it makes a bridge as it were across the site of the tube of the bleeding artery, immediately in front of the point of the finger with which he is shutting up its orifice; he next, either with the same fore-finger of the left hand, or with the side of the extremity of the needle itself, compresses the locality of the bleeding arterial orifice and tube, and then pushes on the needle with his right hand, so as to make it re-enter the surface of the wound a little to the left side of the artery; and, lastly, by pressing the needle farther on in this direction, its point re-emerges through the cutaneous surface of the flap—the site of the tube of the bleeding artery

being in this way left pinned down in a compressed state by the arc or bridge that is passed over it. The needle then passes first through and from the skin of the flap *inwards* to the raw surface of the wound, and, after bridging over the site of the artery, it passes secondly from the raw surface of the wound *outwards* again to and through the skin. Sometimes the needle will be best passed by the aid of the eye alone, and without guiding its course by the finger-tip applied to the bleeding orifice. It compresses not the arterial tube alone, but also the structures placed over and around the site of the tube. When the needle is completely adjusted, all of it that is seen, and that not necessarily so, on the surface of the raw wound, is the small portion of it passing over the site of the artery (Fig. 123); while externally, upon the cutaneous surface of the flap, we have remaining exposed more or less of its two extremities, namely, its point and its head (Fig. 124). The rest of it is

Fig. 123.—Acupressure. First Method. Raw Surface.

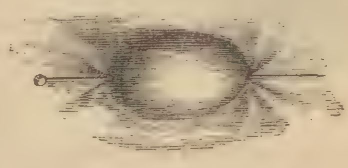


Fig. 124.—Acupressure. First Method. Cutaneous Surface.

hidden in the structures of the flap or side of the wound. The degree of pressure required to close effectually the tube of an artery is certainly much less than Surgeons generally imagine; but in the above proceeding the amount of pressure can be regulated and increased when required, by the acuteness of the angle at which the needle is introduced and again passed out—the cutaneous and other structures of the flap serving as the resisting medium against which the needle compresses the arterial tube.

The *second method* of acupressure consists in taking a short sewing needle with a piece of twisted iron wire attached, for the purpose of withdrawing it when necessary. This is dipped down into the soft tissues on one side of the artery; then bridged over the vessel; then dipped down again into the soft structures on the other side of the vessel (Fig. 125). In doing this, care must be taken to press the end of the needle down upon the bleeding trunk or tube of the artery with sufficient force.

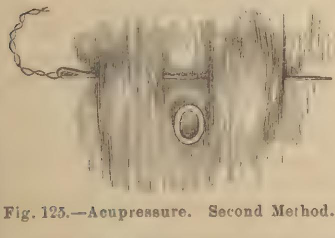


Fig. 125.—Acupressure. Second Method.

Fig. 126.—Acupressure. Third Method.

The *third method* is the one that is likely to be most frequently followed, and is upon the whole the most practical and the best. It consists in compressing the artery between the needle threaded with a piece

of twisted iron wire, passed below or behind it, and a loop of inelastic iron wire passed over or above it. The needle is passed as in the last cases, but on the opposite side of the artery. The loop of iron wire is thrown over the point of the needle; it is then passed across the artery, drawn tight so as to compress the vessel, and secured by a half twist round the eye end of the needle (Fig. 126). In order to remove this apparatus, all the Surgeon has to do is to pull the twisted wire with which the needle is threaded: this, in withdrawing the needle, liberates the loop, which may then easily be removed.

The *fourth method* consists in dipping the needle into the tissues close to the artery, then making a turn with the point, and pushing this into the soft part beyond, so as to fix it there, and thus to compress the artery (Fig. 127).

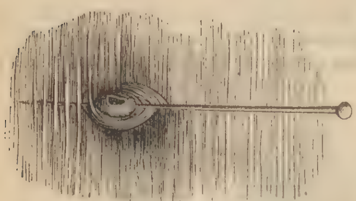


Fig. 127.—Acupressure. Fourth Method.

The *Condition of the Artery* after having been subjected to acupressure has still to be determined. Does the pressure of the needle divide, as the ligature does, the internal and middle coats? or does it merely cause them to adhere by direct compression? In all probability the latter result is the only one obtained; a coagulum forming by the stasis of the blood between the point compressed and nearest collateral branch. This point is one of importance; for there can be little doubt that one of the safeguards after the ligature is this division of the inner coats of the artery, the consequence of which is the effusion of a plastic plug within the vessel, by which it is more effectually sealed than it can be by mere cohesion of its sides and the formation of a blood coagulum.

The time during which the needle should be left in will vary with the size of the artery. As a general rule, it should be from thirty to sixty hours according to the size of the vessel. The needle must not be left in too long, lest irritation be set up, and ulceration induced along its track.

Acupressure and Ligature compared.—That arterial hæmorrhage may be effectually controlled by acupressure in many cases, is undoubted. This fact has long been familiar to Surgeons in the operation for hare-lip, in which the bleeding from the coronary artery is restrained by the pin that is passed across to unite the opposite sides of the cleft, and it has of late years been abundantly proved in the case of the largest arteries divided in amputations. But, though by means of acupressure arterial hæmorrhage may undoubtedly be controlled, the real question which has still to be answered is, whether we are justified in substituting this means for the ligature in surgical practice. When we reflect on the ease and certainty with which the most furious hæmorrhage from the largest artery can be at once and permanently arrested, by the tying of the mouth of the bleeding vessel with a silken thread—the inestimable advantage which the ligature has been and is to Surgeons, in enabling them to carry the knife with safety into regions where its presence would otherwise be fatal—we should not lightly, and on insufficient evidence, throw aside a means of such tried utility for one that is of more doubtful value. And few practical Surgeons will probably discard the thread for the needle in the arrest of arterial hæmorrhage, unless the latter can be proved to be more certain and more safe than the former.

Sir James Simpson, who pressed the subject of acupressure upon the

attention of Surgeons with an amount of zeal, of learning, and experimental research, which is indeed to be admired, advanced a variety of arguments in favor of arresting arterial hæmorrhage by the needle rather than by the ligature. These may briefly be summed up as follows.

The great object of every Surgeon is to heal operation-wounds by the first intention.

A serious and fatal obstacle to this method of healing is the use of the ligature.

The ligature acts injuriously in two ways: 1, each thread acts as a seton and sets up a line of suppuration along its track; 2, the cut end of the artery included in and projecting beyond its noose forms a slough which increases the suppurative action, both by undergoing a process of disintegration and by acting as a foreign body in the wound. Complete healing of a wound to which a ligature has been applied cannot, therefore, possibly take place until after the separation of the ligature and the section of the included arterial tube.

These evils are entirely obviated, and union by the first intention is secured, 1, by the use of metallic compressors, the needle and wire being tolerated by the tissues amongst which they lie, and not acting as setons in the way that hempen or silken ligatures do; and 2, by the early withdrawal of these compressing agents, the vitality of the artery not being endangered and no terminal slough resulting.

That these arguments are sound, it is impossible to deny. The principle on which acupressure is founded is in accordance with the fundamental doctrines of surgical pathology, and must commend itself to every practical Surgeon who dispassionately considers this important question.

But, whilst I admit to the fullest the truth and pathological soundness of the principle on which acupressure is founded, and whilst I cannot but regard any method of treatment which facilitates the early healing of operation-wounds, without suppurative action, as a great step in advance of surgical practice, I cannot but think that, in estimating the comparative value of the Ligature and of Acupressure in the arrest of surgical hæmorrhage, too much evil has been laid to the charge of the thread, and too much advantage has been claimed for the needle.

If the ligature were the sole or indeed the great cause of suppuration in wounds, and of the failure of union by the first intention, it should undoubtedly be discarded in favor of any safe method that would obviate these evils. But is the ligature in reality so injurious? Are there not many cases of want of union by the first intention which are entirely independent of the method adopted for occluding the arteries? The constitutional condition of the patient, irrespective of anything in the local management of the wound (p. 28), as well as the want of homogeneity of tissue (p. 191), and the very nature of the wound itself, have a most decided influence. In many wounds—as in operations for the removal of dead bone, the excision of bones and joints, the ablation of many tumors, &c.,—no attempt at union by the first intention is made; the wound is stuffed perhaps with lint, or the tissues are in such a condition that suppuration is a necessity for healing.

So, again, in amputations (p 71), there are many circumstances that militate against complete primary union, and always must do so. Amongst these may be mentioned the impossibility of close approximation of the flaps, owing to the intravention of the bone; or, in some amputations, as the partial ones of the foot, the very shape of the flap, and the irregularity of the osseous surfaces; the inability of cohesion between

alien tissues, as bone or synovial membrane and muscle, &c. In some cases, undoubtedly, where many or deep ligatures have to be applied, the threads add to the difficulty in effecting direct union. But in many amputations it must be remembered that the chief and perhaps the only ligatures are applied to vessels that, being cut long, are on a level with the edge of the flap. This is the case in amputation of the fore-arm, and at the shoulder, hip, and knee, in amputations of the leg low down, and in all amputations done by the long flap. In such cases, acupressure would do little to aid in accomplishing direct union.

Although, therefore, I do not consider that the ligature is in practice open to the objection which has been laid to its charge, that it is the chief obstacle to the union of wounds by the first intention, yet undoubtedly it is in many instances a hindrance to this desirable result; and, when so, it certainly appears desirable that acupressure should be substituted for it. In many instances, also, and in some even where union by the first intention is not possible, acupressure is a most convenient and safe method of arresting bleeding from vessels which it may be very difficult to expose and tie. Thus, in lacerated or incised wounds of the scalp, in injuries of the hand or foot, the bleeding may often be at once controlled by the pressure of the needle and wire.

Indeed, it appears to me that sound as may be the principle on which acupressure is based, in practice it cannot and need not be substituted for the ligature, but that it may be employed advantageously in conjunction with it, each method being applied to those vessels or in those cases to which and in which it seems most useful; and that the Surgeon will act more wisely in being eclectic rather that dogmatic in the employment of his means for arresting arterial hæmorrhage, in some cases using styptics, in others compression or torsion or the cautery, acupressure or the ligature, as the particular case seems to need it. Because one method is good, the others are not necessarily bad; because one is peculiarly applicable in one case, it does not follow that it is equally so in all.

Collateral Circulation.—When the main artery of a limb has been ligatured, or in any other way occluded, it is only the direct flow of blood that is interrupted; the indirect supply which is conveyed into the limb or part, by the free communication between the anastomosing vessels of the different portions of the arterial system, being sufficient to preserve its vitality, and to prevent the occurrence of gangrene. So free and ready are the inosculations kept up between different portions of the arterial system, that, after the largest arteries in the body, such as the subclavian, iliac, and aorta, have been ligatured, sufficient blood to support life is at once conveyed into the distal parts supplied by them. This **collateral circulation** is most active and most readily maintained in early life, when the vessels are pliant and elastic, readily accommodating themselves to the increased quantity of blood that they are required to convey. As age advances, the vascular system becomes less elastic, and there is a greater difficulty in the establishment and maintenance of the collateral circulation. The anastomosing vessels which serve this purpose are invariably furnished by arteries contiguous to that which is ligatured, and come off from the same side of the body. Thus, for instance, after the ligature of the superficial femoral, it is by the profunda artery that the supply of blood is carried to the lower extremity. Thus also, when the common carotid is ligatured, the circulation to the parts it supplies is not maintained through the medium of the opposite carotid, although the inosculations between the ultimate

branches of the two vessels are so free upon the throat, and the face, and within the cranium; but it is by means of the inferior thyroid and vertebral arteries (branches of the subclavian on the same side), which become greatly enlarged, that the supply of blood is kept up to the parts on the outside, as well as in the inside of the cranium.

The supply of blood that is sent to a limb, after the deligation of the main trunk, is at first but small in quantity; being merely sufficient for the maintenance of its vitality, but not enough for the continuance of the usual function of the part. Hence, although the life of a limb may be preserved after the ligature of its artery, it becomes cold, and the patient is unable to move it for some time, the muscles appearing to be completely paralyzed; gradually, however, the supply of blood increases, until, when it has reached its usual standard, the normal vigor of the part returns.

By what mechanism is this re-establishment of the blood-supply accomplished? It is due to three series of changes taking place: 1, in the Capillaries; 2, in the Anastomosing Branches; and 3, in the Trunk itself.

The **Capillaries** are the first to enlarge; and this they appear to do by a vital process, and not in consequence of the mere increased pressure of the blood; the temperature of the limb often rising, in the course of a day or two, to its normal standard, and sometimes to two or three degrees beyond it, whilst a great sensation of heat is experienced in it by the patient. This period extends over several weeks; and, if opportunity be afforded of examining the limb during its continuance, the tissues generally will be found to be preternaturally vascular, admitting injection freely.

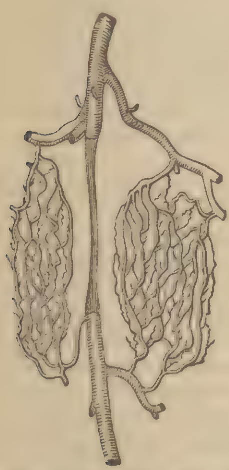


Fig. 128.—Anastomosing Circulation in Sartorius and Pectineus of Dog, three months after Ligature of femoral. (After Porta.)

Fig. 129.—Direct Anastomosing Vessels of Right Carotid of Goat, five months after Ligature. (After Porta.)

Fig. 130.—Change in the Trunk after Ligature, with Anastomosing Vessel.

Coincidently with this increase of activity in the capillary system, the **Anastomosing Arteries** of the part enlarge, becoming serpentine, tortuous, and waved, forming circles or an interlaced net-work. During this enlargement, much pain is often experienced, owing to the pressure

of the enlarged vessels upon neighboring nerves. This form of collateral circulation commences by a general enlargement of all those muscular and subcutaneous secondary vessels of the limb, which can normally be readily distinguished by the naked eye. After this general enlargement has continued for some weeks, it tends to localize itself in a few of the principal anatomical inosculations, until at last it is through their medium that the circulation is chiefly maintained. Thus, for instance, after the ligature of the common carotid, the supply of blood is ultimately conveyed by the inosculations between the superior and inferior thyroid arteries, and by the vertical and basilar. When the subclavian is tied, the circulation of the upper extremity is carried on by the anastomoses between the posterior scapular and suprascapular, and the branches of the axillary artery distributed to the vicinity of the shoulder, and between the intercostals and the long and superior thoracic; and when the external iliac is tied, the blood is conveyed to the lower limb by the inosculations between the mammary and lumbar arteries and the epigastric and circumflex ilii, and by those between the obturator, gluteal, and sciatic arteries and the circumflex branches of the profunda femoris.

Jones pointed out the curious circumstance that, when two anastomosing branches approach one another, they split, before inosculating, into two or three ramusculi, which by uniting form a circle of anastomoses. Besides this kind of collateral circulation, Maunoir, Porta, and Stilling have noticed vessels running directly between the extremities of the obliterated trunk, forming species of arterial shoots, springing from the stump of the vessel (Fig. 129).

The **Change that takes place in the Trunk** consists in its conversion into a fibro-cellular cord, from the point to which the ligature has been applied to the first large collateral branch below it (Figs. 128 to 130); here it becomes pervious again, and, receiving the blood poured into it through the different anastomosing channels, becomes again subservient to the purposes of circulation. Porta and Stilling have shown that, after a time, down the centre of this fibro-cellular cord a small tortuous central canal becomes developed, uniting the two distant ends of the divided artery. This is probably the last change that takes place in the establishment of the collateral circulation.

The collateral circulation is occasionally not sufficiently free to preserve the integrity or vitality of the parts supplied by it. As a consequence of this, gangrene not uncommonly results, or the limb may become paralysed or atrophied. This condition is frequently met with in old people, from ossification and rigidity of the arterial system; or it may happen as the result of copious hæmorrhage, or of an extensive transverse wound of the limb dividing many of the anastomosing vessels. It more rarely happens that we find too great freedom of the anastomoses, so as to lead to a failure of the purposes for which the ligature has been applied, by the rapid admission of blood into the distal side of the vessel, thus perhaps occasioning secondary hæmorrhage.

ACCIDENTS AFTER ARTERIAL OCCLUSION BY SURGICAL MEANS.

The accidents that may follow the application of the ligature, the use of acupressure, or of compression in any way exercised upon wounded arteries, are Secondary Hæmorrhage and Gangrene of the Limb.

SECONDARY OR RECURRENT HÆMORRHAGE.—By this is meant, bleeding from any cause after the employment of the means above mentioned. This accident may arise from a variety of circumstances, which may be

divided into two great classes:—1. *Local Causes*, dependent on the Vessel or Ligature; and 2. *Constitutional Causes*, connected with some Morbid Condition of the Constitution or of the Blood, in consequence of which those changes which are necessary for occlusion of the artery do not take place.

Local Causes.—Among this class of causes may be mentioned any *imperfection in the application of the ligature, needle, or compress;* as, for instance, the ligature being tied too loosely, or with the inclusion of a portion of nerve, vein, or muscle; so also the accidental puncture of the artery above the point to which the ligature is applied.

The *rush of blood through a neighboring trunk or collateral branch* immediately above the ligature has been considered as likely to interfere with the formation of the internal plug; but too much importance should not be attached to this, for Porter has tied the carotid successfully within one-eighth of an inch of the brachio-cephalic artery; Bellingham has ligatured the external iliac close to its origin; and Aston Key, the subclavian in the vicinity of a large branch, without secondary hæmorrhage ensuing. But although the ligature may be safely applied near a branch on its proximal side, I think that the presence of a collateral branch in close proximity to the *distal* side of the ligature—more especially if it be one that serves to carry on the anastomosing circulation—will be found to have a decided tendency to prevent the occlusion of the distal end of the artery, and thus to favor the occurrence of secondary hæmorrhage.

The *wound of a collateral branch* immediately above the ligature, though it does not perhaps give rise to troublesome hæmorrhage at the time, will, as I have seen, cause furious bleeding as the collateral circulation becomes established.

Irritability of the arterial system is very apt to dispose to the occurrence of secondary hæmorrhage. There is a pecular condition of the arterial system indicated by the ordinary evidences of a sanguine temperament—by a full-sized and forcible pulsation of the arteries, in which, when the vessel is exposed, it appears hard, thick walled, and muscular, beats forcibly and almost uncontrollably, in which secondary hæmorrhage is very apt to occur. In these cases the propulsive power of the heart would seem to overcome all those obstacles in the way of internal clot, plastic deposit, and contraction of the vessel on which the occlusion of its calibre depends; and on the separation of the ligature recurrent hæmorrhage will take place in the most vehement and uncontrollable manner.

A *diseased state of the coats of the artery* at the point deligated or compressed will occasion rapid sloughing and unhealthy ulceration of the vessel; those plastic changes which are necessary for its occlusion not going on within it. It has happened that fatal secondary hæmorrhage has occurred from a large artery, such as the femoral, in consequence of a small atheromatous or calcareous patch having given way immediately above the ligature, a day or two after its application.

Constitutional Causes.—These act by preventing the formation of a clot within, and the deposit of plastic matter without, the artery; or by causing their absorption in a few days, if they have been formed. (Figs. 121 and 122.) Amongst the most common of these causes are those unhealthy states of the system in which *diffused erysipelatous inflammation* sets in, which is incompatible with plastic effusion. In these cases either no internal coagulum at all is formed, or it is weak, imperfect, and unable to resist the impulse of the blood; speedily be-

coming absorbed or disintegrated, and washed away. There are also certain states of the blood in which from disease, as albuminuria, it has lost its plasticity, and cannot yield the products of adhesion. Secondary hæmorrhage is specially apt to occur in cases of *pyæmia*, provided that disease assume a somewhat chronic character. The condition of the blood in pyæmia being incompatible with the formation of a firm and plastic coagulum within the artery, the vessel continues or becomes open, and secondary hæmorrhage will certainly occur.

In some cases the secondary hæmorrhage appears to be due to an *excited state of the circulation.* The patient is restless, and has a quick, irritable, and jerking pulse. In such circumstances, bleeding is very apt to occur, and, if not too abundant, appears to give relief to the system.

The occurrence of *erysipelas*, *phlebitis*, *or sloughing of the stump or wound*, will prevent or arrest the necessary adhesive action. The sloughing action set up in a wound may extend to the larger arteries, and by destroying their coats occasion secondary hæmorrhage. But it must be borne in mind that the arterial tissues are usually the last of the soft tissues to slough. An artery will continue to pulsate in a wound, and preserve its integrity while all the adjacent tissues are sloughy and disorganised.

Phenomena.—The occurrence of secondary hæmorrhage is usually somewhat gradual, and not without warning. The blood does not burst forth in a sudden gush, but appears at first in a small quantity, oozing out of the wound and staining the dressings; it may then cease to flow for a time, but breaks out again in the course of a few hours, welling up freely in the wound, and either exhausting the patient by repeated losses, attended by the phenomena that characterise hæmorrhagic fever, or else debilitating him so that he falls a victim to some asthenic disease, such as pneumonia, erysipelas, or phlebitis. In other cases again, after a few warnings, the blood may burst out in a gushing stream that at once destroys life.

The opportunities which I have had of examining the state of the vessels in several cases of fatal secondary hæmorrhage, lead me fully to concur with Guthrie and Porter, that the blood in the great majority of instances comes from the distal and not from the proximal side of the wound. The greater tendency in the distal end of the vessel to bleed, appears to arise partly from the less perfect occlusion of this portion of the artery, and partly from its greater liability to slough, in consequence of the ligature interrupting its supply of blood through the vasa vasorum. It is no objection to this opinion that the fatal hæmorrhage is often arterial; for, though it is true that the blood which is carried to the distal end is, for the first few days after the application of a ligature, of a venous hue, yet, after the collateral circulation is once freely established, it gradually assumes a more scarlet tint, and at last becomes completely arterialised.

Periods at which it occurs.—Secondary hæmorrhage may come on at any time between the application of the ligature and the closure of the wound. There are, however, three periods at which it is particularly apt to occur:—1, a few hours after the ligature has been applied; 2, about the period of the separation of the ligature; and, 3, at an indefinite time after its separation.

1. The hæmorrhage which occurs *a few hours after the application of the ligature*, commonly called **reactionary** or **intermediate**, comes on as the patient recovers from the depressing influence of the chloroform or from the shock of the operation, and arises from some imperfection in

the tying of the ligature. That which occurs some *days* afterwards arises from disease in the arterial coats, causing them to give way; from sloughing; or from want of proper adhesive action on the face of a stump. When it arises from the latter cause, there is a general oozing or dribbling of blood from many points of the surface, rather than a gush from one orifice. In those cases in which the artery has been tied above the wound only, hæmorrhage is very apt to occur at this early period.

2. When hæmorrhage occurs *about the time of the separation of the ligature*, it may arise from any of the causes already specified that interfere with the due formation of an internal coagulum, or that occasion ulceration and sloughing of the coats of the vessel. The occurrence of hæmorrhage at this time is often connected with, or dependent upon, that peculiar irritability of the heart and arteries which has already been mentioned as a frequent cause of bleeding.

3. Lastly, in some cases in which *the ligature has separated but the wound has remained open*, the hæmorrhage may take place either from the cicatrix in the artery being too weak to support the impulse of the blood; or from the coagulum being absorbed in the way already mentioned. The continuance of the open state of the wound after the separation of the ligature, is, I think, not improbably dependent upon a morbid condition of the coats of the vessel which eventually leads to hæmorrhage. The length of time that sometimes elapses between the separation of the ligature and the occurrence of hæmorrhage is very remarkable; thus there is in St. Thomas's Hospital a preparation of a carotid artery, from which secondary hæmorrhage took place in the tenth week after ligature; and South mentions a case of ligature of the subclavian in which the thread separated on the twenty-seventh day, the fatal hæmorrhage occurring in the thirteenth week.

The **Treatment of Secondary Hæmorrhage** must be considered, as the bleeding takes place, 1, from a Stump; and, 2, from an Artery tied in its Continuity.

In all cases of ligature of arteries, care should of course be taken to prevent, if possible, this accident, by keeping the patient perfectly quiet, giving no stimulants, having the bowels kept open and the secretions free, and avoiding any undue traction on the ligature itself.

In primary hæmorrhage the rule of practice is, not to interfere by operation if once the bleeding have been arrested by other means. In secondary hæmorrhage this rule does not apply; but the Surgeon *may* proceed to adopt effectual means for the prevention of the recurrence of the bleeding after the first outbreak, even though all flow of blood have ceased when he sees the patient; and he *must* do so, and that without delay, if the hæmorrhage have recurred more than once. When a repetition of secondary hæmorrhage has taken place, the patient's condition becomes most critical; the efforts of nature can no longer be relied on to arrest the bleeding, and the last and fatal gush may occur at any moment. Hence the Surgeon must in such circumstances lose no time; there must be no dallying, no hoping that the bleeding will not recur, no resorting to temporary and inefficient expedients, but the case must be at once and decisively taken in hand. In no circumstances are more coolness and more surgical knowledge required, than in adopting a decisive and immediate line of action in a case of secondary hæmorrhage. There is no time for delay, no time for consultation, none for reference to books; but the Surgeon must act at once on his own responsibility.

1. When the circulation is irritable and excited, the pulsation free in

a stump, and when the main vessels can be seen several days after the operation beating forcibly at the further ends, the ligatures being jerked up and down, there is great danger of secondary hæmorrhage occurring and the patient must be closely watched; the artery should be digitally compressed, and the diet lowered. In these cases it may sometimes be advisable to have recourse to venesection. The treatment of **secondary hæmorrhage from a Stump** will depend in a great measure on the degree of union that has taken place between the flaps, and on the situation of the stump.

When the hæmorrhage occurs a few days after amputation, if there be but slight oozing, elevating the part, applying cold, and bandaging it tightly with a roller, so as to compress the flaps, will sometimes arrest the bleeding. If it continue, however, or become more severe, the flaps, which will have been disunited by the effusion of blood, must be separated, and the bleeding vessels sought for and tied. When the stump is sloughy, and the tissues softened, the ligatures will not hold; in these circumstances the application of the actual cautery to the bleeding points will arrest the flow of blood. If the oozing appear to be nearly general from the number of points, the flaps being somewhat spongy, I have succeeded in arresting the hæmorrhage by clearing their surfaces thoroughly of all coagula, and then bringing them tightly together by means of a roller.

If the hæmorrhage occur at a later period, after the tenth day, when tolerable union has taken place, and if it appear to proceed from the principal artery of the part, an effort may be made to arrest it by the application of the horse-shoe tourniquet, which occasionally will stop all further loss of blood; or, if the union that had taken place between the flaps have been broken through, the stump may be fairly opened up, the coagula turned out, and the bleeding vessel sought for and tied. If however, notwithstanding the hæmorrhage, the union between the flaps continue sound and firm, then the choice lies between three alternatives: 1, opening up the stump, clearing away coagula, and tying the bleeding vessels at their open mouths; 2, ligaturing the main artery just above the stump; 3, performing the Hunterian operation, and tying the vessel high up in the limb at a distance from the stump. The course to be adopted will, I think, in a great measure depend upon the stump with which we have to do; but as a general rule I prefer in these cases adopting the first alternative, placing a tourniquet on the limb, passing the finger into the stump, and breaking up all adhesions, which are often very firm; then turning out the mass of coagula, which will usually be found distending the flaps, clearing these thoroughly with a sponge, and then tying the bleeding artery. If there be a difficulty in exposing this, or in clearing it so that the ligature will hold, acupressure may be advantageously substituted for the ligature, and the effects of this may be increased by the continuous employment of digital compression in the groin. Besides the main artery that bleeds—one of the tibials, for instance, if it be a leg-amputation—there will generally be very free oozing from many points. The more abundant of this may be stopped by the ligature passed, if the tissues be friable, by means of a nævus-needle under the vessels. The rest will cease on the application of cold water and on raising the stump. The flaps may then be brought together by strips of plaster and a bandage, and will usually very readily unite.

Should, however, the stump be inflamed, sloughy, and œdematous, and more particularly if it be merely the foot or hand that has been

removed, then, instead of opening it up, and seeking for the bleeding vessel, deeply hidden in infiltrated tissues, it will be better to tie the main artery of the limb just above the flaps, or wherever it can be most readily reached. In such cases, after amputation of the foot, I have successfully tied the posterior tibial low down, just above the malleolus.

The third alternative, that of ligaturing the artery high above the stump, should, I think, in the first instance, be undertaken in those cases only where the amputation has been done close to the trunk, as at the shoulder-joint, or the middle or upper part of the thigh, and where consequently there is no length of limb to be nourished by the artery that is ligatured, and where opening up an almost cicatrised stump of very large size would inflict a greater shock upon the system, and more subsequent danger, than the deligation of an artery by an independent operation. Hence, although in no case of secondary hæmorrhage from a leg-stump below the knee would I ligature the femoral in preference to opening up the flaps and securing the vessels in them, if this were practicable, yet in secondary hæmorrhage after the amputation of the thigh, the case might be different; and here, if good union had already taken place, and the stump were not distended by coagula, the main artery might be tied. In such cases it is clearly useless to ligature the superficial femoral, as the hæmorrhage may, and most probably does, proceed from some of the branches of the profunda. Ligature of the common femoral is not very successful; and upon the whole it would, I think, be safer, if all other means have been tried, and have failed, to deligate the external iliac just about Poupart's ligament. In disarticulation of the arm at the shoulder-joint, the subclavian artery must be tied, either above or just below the clavicle.

In any case, the ligature of the main artery of the limb becomes the only and the last resource, where, in consequence of the softened, inflamed, infiltrated or sloughy state of the tissues, the Surgeon is unable to secure the bleeding vessels in the stump itself, the ligatures cutting through the disorganized coats of the vessels.

2. When the hæmorrhage occurs after a ligature has been applied to the **Continuity of the Vessel,** whether for injury or disease, pressure must first be tried. With this view the wound should be plugged, and a graduated compress should be very firmly and carefully applied by means of a ring-tourniquet over the point from which the blood proceeds; in this way the bleeding may occasionally be stopped. Not unfrequently, however, this will prove ineffectual, the bleeding recurring from underneath. When this is the case, what should the Surgeon do? He may re-apply the compress once more with great care, after clearing away coagula, and drying the parts thoroughly; but should it again fail in arresting the bleeding, it is useless to trust to it again, as the hæmorrhage will certainly recur, and valuable time and much blood will be lost in these fruitless attempts at checking it. In such a case as this, the Surgeon must clearly and decidedly determine on the course to be pursued, as there is but "little time for reflection or consultation, and none for referring to authorities."

If the artery be situated on the trunk, as the subclavian, carotid, or one of the iliacs, there is nothing to be done but to trust to the plugging of the wound; and in the great majority of these cases the patient will die exhausted by repeated hæmorrhage.

When the artery is situated in one of the limbs, more efficient procedures may be employed. If it be one of the arteries of the upper

extremity, the wound should be opened up, and an attempt made to tie both ends of the vessel again in this; should this fail, or not be practicable, the artery must be deligated at a higher point than that at which it had been previously tied; should the hæmorrhage continue, or be re-established, amputation is the only resource left.

In the lower extremity, the treatment of secondary hæmorrhage occurring after ligature is replete with difficulty. Here I believe it to be useless to tie the artery at a higher point than that to which the ligature has been already applied, as gangrene is very apt to follow this double ligature of the arteries of the lower extremity: at least in the two or three cases that I have seen in which recourse has been had to this practice, mortification of the limb has ensued: and all in the reported cases with which I am acquainted, a similar result has occurred. The treatment should vary according as we have the femoral artery or one of the tibials to deal with. If the hæmorrhage proceed from the femoral, I should be disposed to cut down on the bleeding part of the vessel, treating it as a wounded artery, and applying a ligature above and below the part already deligated; this operation would, however, necessarily be fraught with difficulty. Should this be impracticable, or not succeed in checking the hæmorrhage, we should best consult the safety of the patient by amputating at once on a level with or above the ligature. Although this is an extreme measure, it is infinitely preferable to allowing him to run the risk of the supervention of gangrene, which will require removal of the limb under less favorable conditions. If the secondary hæmorrhage proceed from one of the tibials, it would be next to useless to adopt either of the preceding alternatives. If we ligatured the superficial femoral, the bleeding would not be permanently controlled, or, if it were, gangrene of the limb would in all probability set in. There are but very few cases on record in which this practice has been followed without mortification occurring. In a few rare instances, however, the ligature of the popliteal has, in such circumstances, succeeded; but it has also frequently failed, rendering secondary amputation necessary, and its success is a mere matter of chance. The depth at which the tibials are situated is so great, that it would be hopeless to search for one of these vessels and attempt its deligation at the bottom of a deep, sloughy, infiltrated, and inflamed wound. In such circumstances, therefore, I think we should amputate the leg above the seat of wound. This is truly a severe measure; but the only other alternative that has, to my knowledge, ever succeeded, is the ligature of the popliteal; and as that, as has already been stated, has frequently failed, I think that, as a rule, we should best consult the safety of the patient by the removal of the limb at once.

If the hæmorrhage occur from a wounded artery to which ligatures have already been applied above and below the seat of wound, the same treatment must be adopted as in those cases in which the bleeding takes place from the application of the ligature to the continuity of the vessel.

Gangrene following Ligature.—After the ligature of the main artery of a limb, the collateral circulation is, under all ordinary circumstances, sufficient to maintain the vitality of the part supplied by the deligated vessel. In some cases, however, it happens that the condition of the circulation in the parts below the ligature is not compatible with their life.

Causes.—The causes influencing the occurrence of gangrene in this way are the Age of the Patient, the Seat of the Operation, and the various Conditions in which the Limb may afterwards be placed.

The influence of *age* is not, however, so marked as might *à priori* be supposed; for, although there can be no doubt that there is a less accommodating power in the arterial system to varying quantities of blood at an advanced period of life, and that there would be greater difficulty in maintaining the vitality of the limb after ligature of the artery in a man of sixty than in one of twenty-five; yet I find that, of thirty cases in which gangrene of the lower extremity followed the ligature either of the external iliac or femoral arteries, the average age of the patient was thirty-five years, as nearly as possible the mean age at which these operations, according to Norris's Tables, are generally performed. Of these cases of gangrene two occurred in persons under twenty years of age, eleven between twenty and thirty, eight between thirty and forty, and nine above forty.

The *seat of the operation* influences greatly the liability to gangrene, which is much more frequent after the ligature of the arteries in the lower than in the upper extremity.

Besides these predisposing causes, gangrene after ligature may be directly occasioned by a *deficient supply of arterial blood.* In some cases this may arise from the collateral vessels being unable, in consequence of the rigidity of their coats, to accommodate themselves to the increased quantity of blood which they are required to transmit; or they may be compressed in such a way by extravasation as to be materially lessened in their capacity. In other instances again, the existence of cardiac disease may interfere with the proper supply of blood to the part.

Great *loss of blood*, either in consequence of secondary hæmorrhage or in any other way, before or after the application of the ligature, is often followed by gangrene, and is almost certain to be attended by this result if a second ligature have been applied to a higher point in the lower extremity. That a diminution in the quantity of blood circulating in the system may, under the most favorable circumstances, become a cause of gangrene after the ligature of the artery, is illustrated by the statement of Hodgson that, soon after the introduction of the Hunterian operation into Paris, it was the custom to employ repeated venesection in the cases operated on; the consequence of which was, that mortification was of frequent occurrence.

A more common cause of gangrene is the *difficulty experienced by the venous blood in its return from the limb.* This difficulty always exists even when no mechanical obstacle impedes the return, being dependent on the want of a proper *vis à tergo* to drive on the blood. The propulsive power of the heart, the main agent in the venous circulation, is greatly diminished by being transmitted through the narrow and circuitous channels of the anastomosing vessels. This difficulty to the onward passage of the venous blood may, if there exist any cause of obstruction in the larger venous trunks, be readily increased to such an extent as to choke the collateral circulation, and so cause the limb to mortify. This mechanical obstacle may be dependent upon the occlusion of the vein by inflammation excited within it opposite the ligature, by its transfixion with the aneurism-needle, or by its accidental wound with the knife in exposing the artery. When such an injury, followed by inflammation, is inflicted on a vein, which, like the femoral, returns the great mass of blood from a limb, gangrene is the inevitable result.

The supervention of *erysipelas* in the limb after the application of the ligature, though fortunately not of very frequent occurrence, is a source of considerable danger, being very apt to give rise to gangrene by the tension of the parts obstructing the anastomosing circulation. I have

on two occasions seen gangrene of the fingers, from this cause, follow ligature of the vessels of the fore-arm.

The *abstraction of heat* from the limb, either directly by the application of cold, or indirectly by the neglect of sufficient precautions to keep up the temperature of the part, often occasions gangrene: thus Sir A. Cooper saw mortification follow the application of cold lead-lotion to a limb in which the femoral artery had been tied; and Hodgson witnessed the same results when the operation was performed at an inclement season of the year.

The *incautious application of heat* may, by overstimulating the returning circulation of the limb, especially about the period when the rising temperature is an indication of increased action in the capillary vessels, occasion mortification. In this way the application of hot bricks and bottles to the feet has given rise to sloughing; and Liston was compelled to amputate the thigh after ligature of the femoral artery, for gangrene induced by fomenting the limb with hot water.

The *application of a bandage*, even though very cautiously made, is apt to induce sloughing and gangrene. I have seen this happen when a roller was applied to the limb after ligature of the femoral artery, with a view of removing the œdema.

The *Period of Supervention* of gangrene of the limb extends over the first three or four weeks after the ligature of the vessel. It seldom sets in before the third day, but most frequently happens before the tenth.

Character.—The gangrene from ligature of an artery is almost invariably of the moist kind, on account of the implication of the veins. The limb first becomes œdematous; vesications then form; and the skin assumes a purplish or greenish-black tint, rapidly extending up to the seat of operation. In some cases, though they are rare, simple mummification of the limb comes on; the skin assuming a dull yellowish-white hue, mottled by the streaks that correspond to the veins, and becoming dry, horny, and shrivelled, about the extensor tendons of the instep.

Treatment.—Much may be done with the view of preventing gangrene. Thus, the limb should be elevated, wrapped up loosely in flannel or cotton-wadding, and laid on its outer side after the operation. If the weather be cold, hot-water bottles may be put into the bed, but not in contact with the limb. Should there be any appearance of stagnation of venous blood, the plan recommended by Guthrie of employing continuous and methodical friction in a direction upwards for twenty-four hours, so as to keep the surperficial veins emptied, may be practised.

When mortification has fairly set in, amputation of the limb should be performed at once as the only chance of saving life, in all those cases in which the patient's constitutional powers are sufficiently strong to enable him to bear the shock of the operation. The limb should be removed at the seat of the original wound, or opposite the point at which the artery has been tied. In those cases, however, in which the gangrene follows injury of the femoral artery just below Poupart's ligament, Guthrie advises that the amputation should be done below the knee, where the gangrene usually stops for a time. If the gangrene spread, with œdema or serous infiltration of the limb, the amputation should be done high up; at the shoulder joint, or in the upper third of the thigh. In these cases a large number of vessels usually require ligature, having been enlarged by the collateral circulation.

CHAPTER XV.

TRAUMATIC ANEURISM AND ARTERIO-VENOUS WOUNDS.

TRAUMATIC ANEURISM.

We have hitherto discussed the treatment of an injured artery having an open wound communicating with it. It often happens, however, that the case is not so simple as has been described, but that, in addition to the wound in the vessel, there is subcutaneous extravasation of blood, with more or less pulsation, thrill, and bruit, from the projection into it of the blood from the wounded vessel. This extravasation constitutes a **Traumatic Aneurism**, and may arise in three ways. 1. There may be an oblique or indirect puncture into the artery, the blood furnished by which partly escapes from the wound, partly extravasates itself into the tissues around the vessel. 2. The puncture in the integuments may have been closed by plaster or bandage; and then no blood escaping externally, although the wound in the artery continues patent, the blood is forced out into the substance of the limb or part. 3. There may have been no external wound, but the artery may have been punctured or torn across subcutaneously, by the spicula of a fractured bone, by a violent strain or twist of the limb, by the injury inflicted in a dislocation, or by the Surgeon in his efforts to reduce it.

These traumatic aneurisms, in whatever way arising, are of two kinds, the *Diffused* and the *Circumscribed*.

Diffused Traumatic Aneurism.—This consists of an effusion of blood poured out by a wounded or ruptured artery with which it communicates; limited in extent by the pressure of surrounding parts, and partially coagulating in the meshes of the broken-down areolar tissue. It has no sac; and its boundary, which is ill-defined, is composed partly of coagulum, and partly of plastic material furnished by the tissues into which the blood is poured out, and has a constant tendency to extend under the pressure of the fluid blood, which continues to be projected into the centre of the tumor.

This form of traumatic aneurism is indicated by a subcutaneous, soft, and semi-fluctuating tumor, often of very considerable size. At first the skin covering it is of its natural color, but it gradually becomes bluish, and is thinned by the pressure to which it is subjected. If the wound in the vessel be rather large and free, there will be a distinct pulsation in the tumor synchronous with the systole of the heart, accompanied by a thrilling, purring, or jarring sensation, and often a distinct and loud bruit. In other cases, if the injured artery be small, or if the wound in it be oblique, and of limited size, there may be no distinct pulsation or bruit; the tumor being either indolent and semi-fluctuating, or having an impulse communicated to it by the subjacent artery. In those cases also in which the artery is torn completely across, or in which the effused blood coagulates very rapidly, the ordinary aneurismal bruit and pulsation may be very obscure or quite absent. In such cases, the diagnosis of the true nature and gravity of the tumor may usually be made by observing that the pulse in the arteries at a lower point is absent, and that there is great œdema of the limb.

These tumors, if left to themselves, rarely undergo spontaneous cure, but they either increase in size until the integument covering them sloughs and ruptures, or the external wound, which has been temporarily plugged by coagulum, gives way; or else they inflame and suppurate, pointing at last, like an abscess, and, on bursting, giving rise to a sudden gush of blood, which may, at once, or by its rapid recurrence, prove fatal. In some cases a subcutaneous breach is made in the coagulated and plastic boundary, and, the blood becoming infiltrated into the areolar tissue, syncope, gangrene, and death follow.

Treatment.—The treatment must be conducted on precisely the same plan as that of an injured artery communicating with an external wound ; the only difference being that, in the case of the diffused traumatic aneurism, the aperture in the artery opens into an extravasation of blood instead of upon the surface. We must especially be upon our guard not to be misled by the term *aneurism*, and not to attempt to treat the condition, resulting from wound or subcutaneous laceration, by the means that we employ with success in the management of aneurism proper. In a pathological aneurism the blood is contained within a sac, which, as will hereafter be shown, is essential for the process of cure of the disease. In the diffused traumatic aneurism there is no sac, properly speaking; and hence these changes to which a sac is necessary cannot take place. I doubt whether there is a case on record in which the Hunterian operation for aneurism, applied to the condition now under consideration, has not terminated in danger or death to the patient, and in grievous disappointment to the Surgeon.

The proper treatment of diffused traumatic aneurism consists in laying open the tumor by a stroke of the scalpel, removing the coagula, dissecting or rather clearing out the artery, and ligaturing it above and below the wound in it. This operation, easy in description, is most difficult and tedious in practice. The bleeding is often profuse; the cavity that is laid open is large, ragged, and partially filled with coagula; it is often with much difficulty that the artery is found under cover of these, and in the midst of infiltrated and disorganised tissues; and when it is found, it is not always easy to get a ligature to hold. It will be convenient to divide this operation into two stages:—1. Exposing the artery; 2. Passing the ligature.

First Stage.—The artery must, if at all practicable, be thoroughly compressed between the tumor and the heart by a tourniquet, or by the hand of an assistant. If it can be so commanded, the diffused aneurism may be at once and freely laid open; but if not, the Surgeon must proceed more cautiously. He must make a small aperture in the most prominent part of the tumor, and introduce two of the fingers of the left hand so as to plug the wound in the integuments, and prevent the escape of blood by it, at the same time feeling for the opening in the artery, and pressing his finger well upon this. Having ascertained that he controls the vessel thoroughly by the pressure of his left index and middle fingers, he may proceed to slit open the wound in the integuments, and clear the clots and blood thoroughly out of the aneurismal tumor.

Second Stage.—The Surgeon will now have exposed the *posterior* part of the aneurismal cavity. The artery must next be cleared for the application of the ligature. If the artery above be commanded by pressure, and there be no immediate danger of hæmorrhage, this may best be done by passing a steel probe, or, what is better, a full-sized bougie, or a sound into the open wound in the artery so as to distend the vessel, dissecting down on each side of this through the posterior

wall of the sac, and then passing the ligature in the usual way. But if the vessel be so near the centre of the circulation that it cannot be efficiently commanded, then the difficulties become far greater, for the Surgeon must on no account remove his finger for an instant from the open wound; but, keeping it firmly and securely pressed into this, he must endeavor, by scratching through the tissues above it, to expose the artery sufficiently to make a dip with the needle around it, and thus to secure it. This part of the operation is by far the most difficult in such cases, on account of the infiltration of the parts and the thickening of the structures preventing the artery from being readily distinguished and easily cleared.

The application of a ligature to the distal end of the vessel, if it be completely divided, is especially difficult. Should it not be practicable, the application of the actual cautery, or pressure by means of a sponge-tent or graduated compress, will be found the best means of arresting the hæmorrhage.

Circumscribed Traumatic Aneurism differs entirely from the diffused in its pathology and treatment, inasmuch as it possesses a distinct sac. There are two varieties of this form of aneurism.

1. In the first variety, a puncture is made in an artery, or the vessel is ruptured subcutaneously, as perhaps in the reduction of an old dislocation; blood is extravasated into the adjoining tissues, and, if there be an external aperture, this cicatrises. The blood that is extravasated becomes surrounded and limited by a dense layer of plastic matter, forming a distinct circumscribed sac, which is soon lined by layers of fibrine deposited from the blood that passes through it. This tumor, usually of moderate size, and of tolerably firm consistence, pulsates synchronously with the beat of the heart, and has a distinct bruit, both of which cease when the artery leading to it is compressed. This form of circumscribed traumatic aneurism most commonly occurs from punctured wounds of small arteries, as the temporal, plantar, palmar, radial, and ulnar.

The **Treatment** to be adopted depends upon the size and situation of the artery with which the tumor is connected. If the artery be small, and so situated that it can be opened without much subsequent inconvenience to the patient, as on the temple or in the fore-arm, it should be laid open, the coagula turned out, and the vessel ligatured above and below the wound in it. If the tumor be so situated, as in the palm, that it would be difficult and hazardous to the integrity of the patient's hand to lay it open, the Hunterian operation for aneurism should be performed, as was successfully done in a case (Fig. 131) in which the brachial was ligatured for an aneurism of this kind in the ball of the thumb, following serious injury to the hand from powder-flask explosion. When it is connected with the superficial palmar arch I have, however, successfully adopted the old operation of laying the tumor open, taking out coagula, and ligaturing the artery at the seat of injury.

Fig. 131.—Circumscribed Traumatic Aneurism in Ball of Thumb after a Powder-flask Explosion.

It is but rarely that this form of traumatic aneurism is connected with a large artery; when it is, the vessel may be ligatured above,

but close to the sac, in the same way as in the next variety. If this form of traumatic aneurism have increased greatly in bulk, so that the skin becomes thin and discolored, or if inflammation ensue, and symptoms of impending suppuration take place around it, then it would be useless to ligature the artery above the tumor, as this would certainly give way, and secondary hæmorrhage follow. Here the proper course is to lay open the sac, turn out the contents, and tie the artery above and below the part that is wounded.

2. The next form of circumscribed traumatic aneurism is of rare occurrence, and usually arises from a small puncture in a large artery, as the axillary or the carotid. The vessel bleeds freely; but, the hæmorrhage being arrested by pressure, the external wound and that in the artery close. The cicatrix in the artery gradually yields, forming, at the end of weeks or months, a tumor which enlarges, dilates, and pulsates eccentrically, with distinct bruit, having all the symptoms that characterise an aneurism from disease, and having a sac formed by the outer coat and sheath of the vessel. It is at first soft and compressible on being squeezed, but becomes harder and firmer, and cannot be so lessened after a time. It consists of a distinct circumscribed sac, formed by the dilatation of the cicatrix in the external coat and sheath of the artery, no blood being effused into the surrounding tissues.

The **Treatment** will vary according to the size of the tumor. If this be small or but moderate in size, it consists in the ligature or compression of the artery leading to the sac, in accordance with the principles that guide us in the treatment of aneurism from disease; though, from the healthy state of the coats of the vessel, the artery may be ligatured as near as possible to the sac.

As there is a distinct cyst or sac in these circumscribed aneurisms, the changes that will be described in the chapter on the Treatment of Aneurisms in general take place; the tumor gradually becoming consolidated, and eventually absorbed. Should, however, the aneurism have attained an enormous magnitude, or should it, from being circumscribed, have become diffused by the rupture of the sac, then the tumor must be laid freely open, the coagula turned out, and the artery ligatured as in the ordinary diffused aneurism.

ARTERIO-VENOUS WOUNDS.

A wound in an artery may communicate with a corresponding one in a contiguous vein, giving rise to two distinct forms of disease—*Aneurismal Varix* and *Varicose Aneurism*. These preternatural communications, which were first noticed and accurately described by W. Hunter, most commonly happen at the bend of the arm, as a consequence of the puncture of the brachial artery in bleeding; but they have been met with in every part of the body in which an artery and vein lie in close juxtaposition, having been found to occur as a consequence of wounds of the subclavian, radial, carotid, temporal, iliac, femoral, popliteal, and tibial arteries. The two forms of disease to which the preternatural communication between arteries and veins gives rise, differ so completely in their nature, symptoms, effects, and treatment, that separate consideration of each is required.

Aneurismal Varix results when, a contiguous artery and vein having been perforated, adhesion takes place between the two vessels at the seat of injury, the communication between them continuing pervious, and a portion of the arterial blood being projected directly into the vein

at each beat of the pulse. Opposite to the aperture of communication between the two vessels, which is always rounded and smooth, the vein will be found to be dilated into a fusiform pouch, with thickened coats. The veins of the part generally are considerably enlarged, somewhat nodulated, tortuous, and thickened. The artery above the wound is dilated; below, it is usually somewhat contracted. These pathological conditions are evidently due to a certain quantity of the arterial blood finding its way into the vein, and distending and irritating it by its pressure and presence, and less consequently being conveyed by the lower portion of the artery.

The **Symptoms** consist of a tumor at the seat of injury, which can be emptied by pressure upon the artery leading to it, or by compressing its walls. If subcutaneous, this tumor is of a blue or purple color, of an oblong shape, and will be seen to receive the dilated and tortuous veins. It will be found to pulsate distinctly with a tremulous jarring motion, rather than a distinct impulse. Auscultation detects in it a loud and blowing, whiffling, rasping, or hissing sound, usually of a peculiarly harsh character. This sound has very aptly been compared by Porter to the noise made by a fly in a paper-bag, and by Liston to the sound of distant and complicated machinery. The thrill and sound are more distinct in the upper than in the lower part of the limb, and are most perceptible if the limb be allowed to hang down so as to become congested. Besides these local symptoms, there is usually some vascular weakness, together with diminution in the temperature of the part supplied by the injured artery.

Treatment.—As this condition, when once formed, is stationary, all operative interference should be avoided, an elastic bandage merely being applied. Should a case occur in which more than this is required, the artery must be cut down upon and ligatured on each side of the wound in it. Holmes suggests that possibly in aneurismal varix a cure might be obtained by pressure directed solely to the orifice in the vein.

Varicose Aneurism.—In this case the openings in the artery and vein do not directly communicate (see Figs. 133 and 135), but an aneurismal sac is formed between the two vessels, into which the blood is poured before passing into the vein.

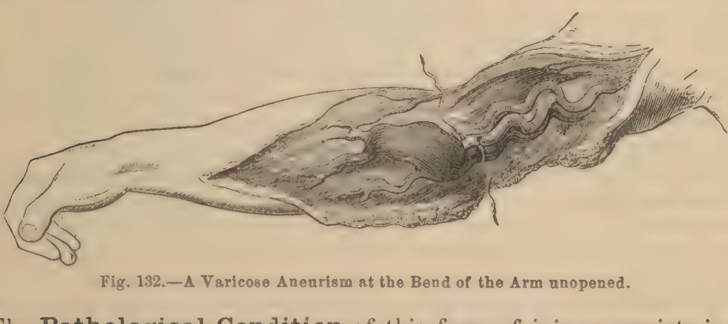


Fig. 132.—A Varicose Aneurism at the Bend of the Arm unopened.

The **Pathological Condition** of this form of injury consists in the formation of a circumscribed false aneurism, communicating on one side with the artery, and on the other with the vein, which is always in a state of varix. A varicose aneurism is, in fact, a circumscribed traumatic aneurism *plus* an aneurismal varix. This condition is well represented in the annexed cuts, from drawings of Sir C. Bell's, in the Museum of University College, representing a varicose aneurism be-

Fig. 133.—The same Varicose Aneurism removed from its Connexions.

fore and after it had been opened (Figs. 132 to 134). In this case there appears to have been a high division of the brachial, and a communicating branch below the wound, between the radial and ulnar; in consequence of which, as Mr. Shaw informs me, the tumor pulsated as forcibly after the operation as before, and, the blood finding its way back through the aneurism into the veins, gangrene of the hand and arm was produced.

Symptoms.—In the symptoms of varicose aneurism, we have a combination of the characters of aneurismal varix and of the circumscribed traumatic aneurism; there is a pulsating tumor, at first soft and compressible, but, after a time, assuming a more solid consistence, in consequence of the deposition of fibrine within it: above this tumor, the vein that has been punctured is dilated into a fusiform pouch, presenting the ordinary characters of varix. The sounds heard in these tumors are of two distinct kinds: there is the peculiar buzzing thrill that always exists where there is a preternatural communication between an artery and vein; besides this, there is a blowing or bellows sound, dependent on the aneurismal disease. These signs are most perceptible when the limb is in a dependent position; and the sounds can often be heard in the veins at a considerable distance from the seat of injury. There is also some impairment in the nutrition and temperature of the parts supplied by the injured vessels. As the disease advances, the aneurismal tumor lying between the artery and vein continues to increase in size, and to become hardened by the deposition of laminated fibrine. If left to itself, it would probably continue to enlarge until sloughing of the integuments covering it occurred, followed by hæmorrhage. In some cases, the aperture of communication between the vein and sac becomes closed, and the aneurism is converted into one of the false circumscribed variety.

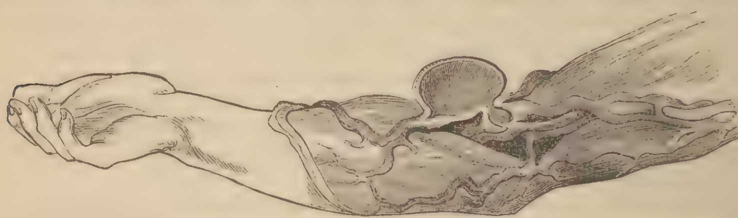


Fig. 134.—The same Tumor laid open, showing the Circumscribed False Aneurism between the two Vessels.

Treatment.—The treatment of this disease must be conducted on different principles from those that have been laid down as required in the ordinary circumscribed traumatic aneurism; the difference depending upon the fact, that in the varicose aneurism there is always a double aperture in the sac, and that thus the proper deposition of laminated fibrine necessary for its occlusion cannot take place. The sac of such an aneurism may be compared to one that has been ruptured, or accidentally opened, in which we could consequently not expect the occurrence

of those changes that are necessary for the cure of aneurism by the Hunterian operation.

In a varicose aneurism, consequently, the sac must be freely incised, and the artery tied on each side of the puncture in it. This procedure may, unless the Surgeon be careful, and properly understand the pathology of this disease, be attended by some difficulty (Fig. 135). The operation may, however, be greatly simplified by exsanguinating the limb by means of the elastic roller and the tourniquet. If this ingenious device be adopted, the Surgeon will be able to see clearly what he is about. After the first incision has been made through the integuments, the dilated vein will be laid open, and an aperture will be seen at the bottom of the vessel, from which arterial blood may be made to issue by relaxing the tourniquet. If an attempt be made to find the artery immediately below this aperture, the Surgeon will be disappointed, for the sac of the circumscribed aneurism intervenes between the two vessels. That this aperture leads into the sac, and not into the artery, may readily be ascertained by introducing a probe into it, which will be seen to be capable of being carried sideways, as well as upwards and downwards, to a considerable extent, and in different directions altogether out of the course of the artery. In order to expose this vessel properly, a probe-pointed bistoury must be introduced into this opening, and the sac of the false aneurism slit up to its full extent, the coagula turned out, and the puncture in the artery sought for in the bottom of the cavity that has been exposed; this may now readily be made visible by the escape of a jet of arterial blood on relaxing the pressure on the upper part of the artery; a ligature must then be passed above and below the wound, and the cavity lightly dressed with lint.

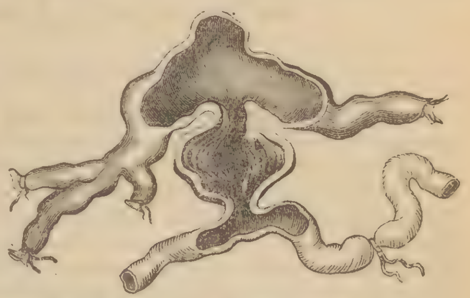


Fig. 135.—The opened Tumor removed from its Connexions. Application of Ligatures.

Vanzetti has recorded a case of varicose aneurism of the brachial artery cured in six hours by **digital compression**, applied simultaneously to the artery above the tumor, and to the orifice leading from the sac into the vein. Franzolini cured a case in the same way, after sixty days' compression, at irregular intervals. In Fischer's tables are twelve cases of varicose aneurism, nine of which were cured by digital compression. In at least four of these cures it was applied as above described. It seems, therefore, that digital pressure is a hopeful mode of treating such cases.

CHAPTER XVI.

WOUNDS OF SPECIAL BLOOD-VESSELS.[1]

VESSELS OF THE HEAD AND NECK.

Carotid Artery.—**Wounds of the Carotid Artery**, and of its primary and secondary divisions, are more frequent in civil practice than similar injuries of any other set of arteries in the body, in consequence of the neck being frequently the seat of suicidal attempts. The hæmorrhage from wounds of the main trunk is so copious as often to be immediately fatal. In the event of a Surgeon being at hand, both ends of the bleeding vessel must be at once ligatured. Should the hæmorrhage, whether primary or secondary, proceed from a deep branch, as the internal maxillary, deep temporal, or internal carotid, so situated as not to admit of the vessel being exposed and ligatured at the seat of wound, the ordinary rule or practice of tying a wounded artery at the seat of injury must be departed from, and the common carotid tied in the neck.

In consequence of the speedy fatality of the wounds of the carotid artery and its branches, **Traumatic Aneurisms** are rarely met with in this situation; they do, however, occasionally occur, and the records of surgery contain at least six instances of the kind, in each of which the common carotid was tied, and the patient ultimately recovered.

Aneurismal Varix in the Neck, dependent on puncture of the **Internal Jugular Vein and Carotid Artery**, usually the result of sword-thrusts, is apparently of more frequent occurrence than traumatic aneurism in this region; probably owing to the close proximity of the vein rendering it difficult for the artery to be wounded on the outer or anterior sides, without first perforating that vessel. The symptoms offer the general characteristics of aneurismal varix, but have several points that are worthy of special remark. The wound of the vessels has been in every instance followed by the effusion of a large quantity of blood into the loose areolar tissue of the neck; the extravasation acquiring even the size of a child's head, and threatening immediate suffocation. As this extravasation subsided, the ordinary characters of aneurismal varix began to manifest themselves. The period at which these symptoms first made their appearance varied somewhat in the different cases, but they always occurred within four or five days of the receipt of the injury. In none of the cases did the disease appear to shorten life, or to occasion any dangerous or inconvenient effects, with the exception of some diffculty in lying on the affected side, and occasional giddiness or noise in the head on stooping. No operation is admissible in these affections.

Varicose Aneurism is very rarely met with in this situation. There is indeed only one case on record. It was situated close to the skull, and resulted from a bullet wound.

Temporal Artery.—**Traumatic Aneurism of the Temporal Artery**, and of its branches, occasionally occurs as the result of partial

[1] A full description of the operations required for the ligature of the various arteries will be found in Vol. II., Chapters XLIII. and XLIV.

division of these vessels in cupping on the temple. I have met with two cases of this kind, in both of which the disease was readily cured by laying the tumor open, turning out its contents, and tying the artery on each side of it.

Hæmorrhage from the **Deep Arteries of the Face**, as in gun-shot injuries, if too copious to be restrained by cold, requires the ligature of the common or external carotid.

VERTEBRAL ARTERY.—**Wounds of the Vertebral Artery** occasionally occur as the result of stabs in the neck; and several cases of traumatic aneurism in this situation have been recorded. In these wounds there is a danger of mistaking the source of the hæmorrhage, as pressure on the carotid, if made below the transverse process of the sixth cervical vertebra, arrests the flow of blood in the vertebral as well, which up to this point, lies immediately beneath it. This transverse process is at least two inches above the clavicle, and lies much higher than is usually supposed. There are no less than eleven cases on record, in which the carotid has been tied for a wound of the vertebral, in consequence of this mistake. When the wound of the artery is situated between two transverse processes, ligature is almost impossible, and the Surgeon will be obliged to trust to plugging the wound, and to the use of styptics. The recorded cases of this injury are fully reviewed by Holmes in his lectures on the Surgical Treatment of Aneurism.

VESSELS OF THE UPPER LIMB.

SUBCLAVIAN ARTERY.—A **Wound of the Subclavian Artery** may almost invariably be looked upon as fatal; though, in consequence of the manner in which the vessel is protected by the clavicle, this injury can scarcely occur except from gun-shot violence. From the rapidly fatal nature of wounds of the subclavian artery, **Traumatic Aneurisms** in this situation are not met with; but where the artery passes into the axilla below the margin of the first rib, they are not unfrequent.

Aneurismal Varix, resulting from wound of the *Subclavian Artery and Vein*, has been seen, notwithstanding the separation that exists between the two vessels, throughout their whole extent. These injuries have likewise usually been the result of sword-thrusts, and do not admit of any surgical interference.

AXILLARY ARTERY.—In **Open Wounds of the Axillary Artery and of its Branches**, the rule of practice consists in cutting down upon the bleeding vessel and ligaturing it on each side of the wound. It must be borne in mind that, the arterial branches given off between the lower edge of the first rib and the fold of the axilla being very numerous, a punctured wound of the axilla or side of the chest may injure one of these vessels; though from its course, and the free flow of arterial blood that has followed the stab, it may be supposed that the axillary artery itself has been punctured. The particular vessel injured can only be ascertained by following up the wound, and ligaturing the artery that furnishes the blood.

In some cases, however, the state of the parts may be such, that it may be impossible to trace the artery at the depth at which it is situated, or even to expose it in a more superficial situation, as in the stump after amputation at the shoulder-joint. In these circumstances, the rule of ligaturing an artery at the seat of injury may be departed from, and the main trunk should be tied either above or below the clavicle; and the success of this operation has been sufficient to justify our having recourse

to it, rather than exhaust the patient by any prolonged attempts at the ligature of the vessel in the open wound, though I think that this ought first to be attempted. Of 15 cases in which the artery has been ligatured either above or below the clavicle, for hæmorrhage from wounds in the axilla or from stumps, I find that 9 were cured and 6 died. Although the success is about equal in whichever situation the vessel be tied, I should certainly give the preference to the supraclavicular operation, owing to the greater facility of its performance, and the comparative absence of collateral branches at the seat of ligature. In some cases, however, especially after amputations at the shoulder, the clavicle is pushed up at its acromial end, and then the artery might be best reached below the clavicle, under or through the pectoral muscles.

Traumatic Aneurism in the Axilla is not of unfrequent occurrence, arising directly from gun-shot wounds, or from the thrust of a knife, sabre, or other pointed weapon. In some cases the injury arises from a subcutaneous rupture of the vessel, the patient stretching out and straining his arm in an attempt to save himself from falling, and sudden snap in the axilla, which is followed rapidly by the formation of a diffused aneurism.

There are several cases on record in which axillary aneurism has resulted from violent attempts made by the Surgeon in the reduction of old-standing dislocations of the head of the humerus. Thus Pelletan mentions a case of this kind, in which the tumor, being supposed to be emphysematous, was opened, and the patient perished of hæmorrhage. Warren relates a case of diffused axillary aneurism resulting from rupture of the artery, in consequence of the Surgeon attempting to reduce a dislocation of the humerus by using his foot as a fulcrum in the axilla, but without taking off his boot. Gibson has related three cases of axillary aneurism following rupture of the artery, in the attempt to reduce old-standing dislocations with the pulleys. These cases are of much interest to the Surgeon, as showing the necessity for great caution in the use of powerful extending force in the reduction of old dislocations, adhesions having possibly formed between the artery and head of the bone.

In those cases of diffused traumatic aneurism of the axilla that arise from subcutaneous rupture or laceration of the artery, the condition of parts is essentially the same as in the case of an open wound of the vessel, with the exception of the absence of any external aperture in the integuments. In these cases a tumor of considerable size, hard or fluctuating, according to the state of coagulation of its contents, forms with more or less rapidity. If it have formed very quickly, the artery being torn across, and the blood coagulating as it is effused, it will not present the ordinary aneurismal signs, but may merely resemble an ordinary extravasation; from this, however, it may be distinguished by the loss of the pulse at the wrist, and by the œdema of the arm. If it form slowly, the blood continuing fluid, there will be the usual signs of aneurism, such as thrill, pulsation, and a gushing hot sensation. In all these cases, there is much œdema of the arm, with a tendency to inflammation, suppuration, and sloughing of the tumor and the parts amongst which it lies, with perhaps gangrene of the limb itself.

Some of these traumatic axillary aneurisms have a tendency to diffuse themselves with great rapidity, filling up the whole of the hollow of the armpit, and extending under the pectoral muscles, even up around the shoulder. In other cases again, when more circumscribed, the disease may get well spontaneously, as happened in cases recorded by Van

Swieten, Sabatier, and Hodgson. In other instances again, the disease has remained stationary for years, or has even undergone consolidation under medical treatment. It cannot, however, be considered sound practice to leave a traumatic aneurism of this artery without surgical interference, after the ordinary dietetic and hygienic plans of treatment have failed in effecting a cure, for it may at any time become rapidly diffused, or inflame and suppurate.

The *Treatment* of traumatic axillary aneurism must depend not only on the question whether it be diffused or circumscribed; but, if diffused, whether it be of recent origin, or have originated from puncture or from subcutaneous rupture or laceration of the vessel as a consequence of dislocation, fracture, blow, or strain.

When a *diffused traumatic aneurism* of recent origin, rapid formation, and dependent upon puncture of the artery, is met with in the axilla, the treatment must be conducted in the same way as that of a wounded artery, without extravasation, in this situation. As Guthrie very justly observes, it can make no difference whether the puncture in the skin has healed or not—the condition of the artery must be the same. The tumor should be laid open, the coagula turned out, the artery sought for, and ligatured where wounded. There is, however, danger after this operation, either of secondary hæmorrhage coming on from the seat of wound, by blood conveyed through the collateral vessels which open into the subscapular and circumflex arteries; or else of the limb falling into a state of gangrene. In either case, amputation of the shoulder and through the aneurismal extravasation is the only practice that holds out a chance of life to the patient.

In diffused traumatic aneurism of the axilla from subcutaneous rupture or laceration of the axillary artery, the choice would lie between treating the injury by direct incision, and ligaturing the vessel above the clavicle. The ligature of the vessel above the clavicle has been done three times, with only one recovery, two of the patients dying of gangrene and secondary hæmorrhage. In the successful case, secondary hæmorrhage had occurred; and gangrene of the arm, which threatened, was prevented, and the patient saved, by amputation at the shoulder-joint. The result, therefore, of ligature is so little promising, that few Surgeons would be disposed, in the face of these facts, to repeat this operation.

The only other alternative consists in treating the ruptured artery on the same principle as a wounded one, disregarding the accidental complication of the subcutaneous accumulation of a few ounces or pounds of blood. This undoubtedly is the proper surgical principle on which to act in these cases. Its adoption has been strongly urged by Guthrie, and its advantage has been demonstrated by the success attending it in several cases in which it has been adopted by Paget, Syme, and others. The operation consists in compressing the subclavian above the clavicle, either by the direct pressure of the finger, or, as was done by Syme in his case, by previously making an incision over it, through which it could be more readily commanded; then laying the tumor open by a free incision through the anterior fold of the axilla and the pectoral muscles, turning out the coagula, and seeking for and ligaturing the artery at both ends; for it must be remembered, that the distal extremity of the torn vessel will probably bleed freely, owing to the open anastomoses round the shoulder.

Circumscribed Traumatic Aneurisms of the Axillary Artery are not uncommonly of slow formation, existing for several months or

years before they require operation, although resulting from punctured wound of the armpit. In chronic cases of this kind, the aneurism is necessarily provided with a firm and distinct sac, and approaches closely in its characters to the pathological form of the disease.

The *Treatment* here cannot be conducted on the principles that guide us in the management of a wound, or of a diffused aneurism of recent occurrence of this artery; for not only is the circumscribed aneurism provided with a sac, but the vessel at the point injured will very probably be found to have undergone changes that render it little able to bear the application of the ligature. It will be softened, thickened, and lacerable, with perhaps a wide funnel-shaped aperture leading into the sac, which will be closely incorporated with the neighboring parts. But, indeed, the treatment of this form of circumscribed traumatic aneurism by the ligature of the artery on the proximal side of the sac, has been found to be attended with remarkable success. In eight recorded cases in which this operation has been performed, not one fatal result has been noted. In all, the aneurism arose from stabs or gun-shot wounds, and had existed for various periods, between two weeks and four years. In four of the cases the artery was ligatured above, and in four below the clavicle; and in one case of each category there was suppuration of the sac.

The particular point at which the artery should be ligatured must depend upon the condition of the tumor. If this be of large size, or arise from the upper part of the axillary artery above or immediately below the pectoralis minor muscle, there is no choice but to deligate the vessel above the clavicle. Should, however, the principal increase in the tumor take place in a direction downwards and forwards under the great pectoral muscle, the portion of the artery immediately below the clavicle appearing to be free from disease, the question would arise as to whether this part might not be selected for the application of the ligature; and as the results of both operations have hitherto been equally favorable, this must rather be determined by the peculiarities in each case than on more general grounds. Most Surgeons, I think, would however prefer ligaturing the artery above the clavicle, as being a simpler proceeding than tying it below that bone; which, moreover, has the disadvantage of bringing the scalpel into very close proximity with the sac, which, were it to stretch upwards under the pectoralis minor to a greater extent than could be discernible externally, might possibly be opened by the knife, as has even happened in operating above the clavicle. It has been recommended to apply the ligature between the sac and the origins of the subscapular and posterior circumflex arteries, below the former and above the latter; but this is an anatomical impossibility, if the aneurism be situated above the lower border of the axilla.

Compression of the artery on the distal side of the tumor succeeded in curing the disease in a case that was under Goldsmith of Vermont.

Brachial Artery.—The hæmorrhage from **Wounds of the Brachial Artery** may sometimes be arrested by the employment of methodical compression, but usually it requires the ordinary ligature on each side of the aperture.

This vessel may occasionally be punctured in venesection. This accident, which was formerly of frequent occurrence when venesection was practised by professed phlebotomists, now very rarely happens. Should a Surgeon be so unfortunate as to puncture the brachial artery in this way, he may prevent injurious consequences by keeping up a proper degree of pressure, by means of a graduated compress applied immediately on the occurrence of the accident. With this view, the fingers,

hand, and fore-arm have been very carefully padded and bandaged, a well-made graduated compress should be firmly applied over the seat of puncture, and retained there for at least ten days or a fortnight. Should the aperture in the artery not be closed in this way, either a circumscribed false aneurism, a varicose aneurism, or an aneurismal varix will form, according to its situation in relation to the vein.

In the **Circumscribed Traumatic Aneurism** at the bend of the arm, following a wound of the brachial artery, we have the usual soft or semi-solid pulsating tumor, which can readily be emptied on pressure, and possesses more or less bruit. This disease may be *treated* in one of three ways: 1, by compression upon or above the tumor; 2, by ligaturing the artery leading to it; or 3, by cutting through the sac, and deligating the vessel on each side of the aperture in it.

The compression of the tumor has often been successfully practised. It may be done by means of a graduated compress on the tumor, and the application of a ring-tourniquet over the artery: the tumor becoming consolidated, and gradually undergoing absorption. In employing compression great care must be taken, however, not to induce sloughing of the tissues over the tumor by sudden and too forcible pressure. The limb should be carefully bandaged up and maintained in the semi-flexed position. Should this plan not succeed, we must be guided in our ulterior measures by the particular conditions of the case. If the tumor be of recent origin, soft and compressible, or, though of longer duration, large, with a thin sac, and danger of becoming diffused, it should be treated by direct incision, and the artery be deligated on each side of the wound in it. Should, however, the tumor be small, or but of moderate size, and the sac be tolerably thick and firm, so as to admit of the deposit of laminated fibrine, we may treat it by deligation of the brachial artery, either in the middle of the arm, or, as Anel did with success, immediately above the tumor. In the event, however, of the disease not being cured in this way, incision of the sac must be had recourse to, as I have known to be necessary in a case in which the brachial artery was tied above the tumor, which was large, with a thin sac, the pulsations returning in a few days, and the tumor continuing to enlarge.

Varicose Aneurism, at the bend of the arm, presents the ordinary character of the disease. Occasionally, though rarely, it would appear that the aperture of communication between the aneurismal sac and the vein becomes closed, and thus the varicose is converted into the ordinary circumscribed traumatic aneurism.

The *Treatment* of this affection must be conducted on different principles from that of the ordinary circumscribed variety; for whatever be the density of the sac, it is never, as has already been explained (p. 328), a perfect one, having always an opening into the vein which would prevent its proper closure by the deposit of laminated fibrine. In four cases related by Sabatier, which were treated by Anel's operation, amputation became necessary in two; and, in the other cases, the operation by incision of the sac was required before a cure could be effected. The sac must therefore be laid open, and the vessel tied on each side of it in the way that has been recommended in the treatment of varicose aneurism, and with the caution there laid down. If the varicose aneurism be converted, after a few days, into the circumscribed form, the aperture into the vein becoming occluded, ligature of the artery above the sac may be successfully employed, or compression may succeed in curing the disease.

In **Aneurismal Varix** of the arm, a roller and compress are all that can be required.

Vessels of the Fore-arm and Palm.—The arteries of the fore-arm are very commonly wounded by pieces of glass or earthenware, or by knives. In every case the bleeding point must be cut down upon, and both ends of the vessel tied. This rule is peculiarly imperative in this situation, on account of the freedom of the anastomosis through the palmar arches. In many of these cases the bleeding is at first very free, but, being arrested by pressure, does not break out again until eight or ten days have elapsed; when, the arm being much infiltrated with blood, inflamed, and swollen, double ligature of the vessel at the seat of injury has to be practised under somewhat difficult and unfavorable circumstances.

Traumatic Aneurism of the Radial and Ulnar Arteries usually assumes the circumscribed form, owing to the pressure employed at the time of injury confining the extravasation. If it be small and recent, and situated superficially at the lower part of the fore-arm, or if it be in any way diffused, the better plan is to cut down upon and through the tumor at once, ligaturing the vessel on each side. If, however, the aneurism be deeply seated amongst the mass of muscles at the upper part of the fore-arm, near the elbow-joint, the wound having healed, and the soft parts covering it being healthy and firm, the advice given by Liston appears to be most judicious: rather than cutting through the muscles and detaching their connections, he recommends that the aneurism should be left to attain some consistence, and then that the brachial artery be secured in the mid-arm. In such cases as these, also, compression of the brachial, with moderate pressure on the tumor itself, has effected a cure.

Wounds of the Palmar Arches not unfrequently occur from the breaking of glass or china in the hand, or stabs from some pointed instrument, and are always troublesome to manage. If the Surgeon sees the case shortly after the infliction of the wound, he may endeavor, by enlarging the aperture to a moderate extent, and with due attention to the tendons and nerves of the part, to secure the bleeding vessel. Should he fail in doing this, which he certainly will if it be the deep arch that is injured, a graduated compress must be well and firmly applied. If this be properly done, it will very commonly be an effective means of arresting the hæmorrhage. If it be loosely and ineffectually put on, it will be worse than useless. The proper mode of putting on this compress is as follows. A tourniquet having been applied on the brachial artery, the wound must be carefully cleared of all foreign bodies, and wiped dry; each finger is then to be separately and carefully bandaged. A wooden splint is then to be put on the back of the hand and the lower part of the fore-arm. A firm well-made graduated compress is now to be placed with the apex downwards on the wound, so as to bring and press the edges together, and securely bandaged against it. The circulation through the limb should still, if possible, be controlled with a ring-tourniquet, applied on that artery above the wrist which appears most to correspond with the arch wounded, or better still, on the brachial itself; or the elbow may be forcibly flexed, and the fore-arm bandaged to the arm in this position, so that the hand rests upon the shoulder. The compress and limb must be left undisturbed for at least five or six days, when, the brachial being compressed, the dressings may be taken off, and the state of the palm examined. Should the wound be healing and look well, the hand-splint and compress may

be re-applied; but should the palm be sloughy and infiltrated, with a tendency to hæmorrhage, it will be useless again to resort to compression, and other means must be employed.

Should an ineffectual attempt have been made to arrest the primary hæmorrhage, or should the case not be seen until several days have elapsed, when secondary hæmorrhage has occurred, and the palm has become infiltrated and swollen, pressure can no longer be borne upon the seat of injury, and it is useless to endeavor to search for the injured vessel in the midst of sloughy and infiltrated tissues, through a narrow wound which cannot be enlarged without danger of disorganising the hand. In these circumstances, it is necessary to deviate from the ordinary rule of practice in wounded arteries, and the Hunterian operation must be performed. The Surgeon may either tie both arteries above the wrist, or at once deligate the brachial. Both methods of treatment have their advocates. I prefer the simultaneous ligature of the two arteries of the fore-arm, just above the wrist, where they are superficial and very easily reached. In several cases under my care, the radial and ulnar, immediately above the hand, have been tied at the same time with complete success, and I have never seen a case in which this operation has failed; but should it do so, or should hæmorrhage occur after this, as might happen in the case of an enlarged median or interosseous artery, the Surgeon must have recourse to compression or ligature of the brachial.

Circumscribed Traumatic Aneurism in the Palm is by no means of frequent occurrence. It may, however, follow wounds of the palmar arches. In such a case as this, it would be clearly out of the question to lay open the sac, and to search for the injured vessel in the midst of the aponeurotic and tendinous structures of the hand. It would consequently be necessary, either to tie the radial and ulnar arteries immediately above the wrist, or to ligature the brachial in the middle of the arm. The latter plan should be preferred; as, were the first mode of treatment put into practice, the sac might continue to be fed by the interosseous artery, as happened in a case of Roux's, in which the patient died of hæmorrhage from the palmar aneurism after the ligature of both arteries of the fore-arm. In the case represented (Fig. 131), Liston successfully ligatured the brachial in the mid-arm, after compression upon it had failed to effect a cure.

VESSELS OF THE LOWER LIMB.

Femoral Artery.—The hæmorrhage from the **Femoral Artery, Common, Superficial, or Deep**, when wounded is always very profuse. In all cases, ligature of the wounded vessel at the seat of injury should, if possible, be practised.

If a **Diffused Traumatic Aneurism** have already formed, the artery should be commanded by a tourniquet, as it passes over the brim of the pelvis, the sac laid open, and the bleeding vessel sought for and tied. Guthrie has collected a great number of cases, which prove incontestably that the general principles of treatment in wounded arteries must not be departed from, when the arteries of the groin or thigh are wounded. On the contrary, the facility with which in most cases the circulation is kept up, and the readiness with which secondary hæmorrhage comes on as a consequence of the free anastomoses in this situation, render the rule of practice of applying a ligature on each side of the wound in the vessel peculiarly stringent in all recent arterial wounds

in this part of the body. Secondary hæmorrhage and gangrene of the limb are the great sources of danger here. When gangrene is imminent, or has come on, amputation is necessarily the sole resource. With regard to secondary hæmorrhage supervening after ligature of the artery, *at the seat of injury*, there is, I think, no safe course but removal of the limb. Where the artery has been tied higher up, as, for instance, when the external iliac has been ligatured for recent wounds or traumatic aneurisms in the groin or upper part of the thigh, the hæmorrhage appears to have returned, or gangrene to have supervened in all the cases. This fact was remarkably illustrated in the Crimean War. Thus, Macleod states that the French in one hospital at Constantinople ligatured the femoral at a distance from the wound for secondary hæmorrhage seven times, and that all the cases failed.

If the traumatic aneurism have assumed a *circumscribed* character, it must be treated on the principles laid down for this form of the disease, the supplying artery being ligatured above the tumor; and cases are not wanting in proof of the success of this practice.

It occasionally, though rarely, happens that a **Varicose Aneurism** is formed in the groin or upper part of the thigh, as the result of wound of the artery and vein in this situation. It usually presents the ordinary characters of this disease, but some peculiarities have occasionally been met with. Thus, in a case related by Horner, there was a wavy motion in the femoral vein on the uninjured side, arising from the blood in the wounded vessel communicating a thrill upwards to that contained in the vena cava. In a case related by Morrison, it is stated that a tumor, as large as the human uterus at the third month of pregnancy, communicated with the injured vein.

The *Treatment* of this disease is exceedingly unsatisfactory. Of four cases in which the external iliac artery was tied, a fatal termination occurred in every instance; two of the patients dying of gangrene of the limb, and the remaining two of secondary hæmorrhage and consecutive pneumonia. It has consequently been proposed by Guthrie that the tumor be laid open, and the artery secured above and below the aperture in it. As this plan has never been fairly put into practice, it would perhaps be useless to speculate on the chances of success likely to attend it; yet we must bear in mind, that laying open an aneurism of this kind in the groin is a very different matter from adopting the same procedure at the bend of the arm, or in a situation where the Surgeon can readily command the artery on the proximal side of the sac. The gush of blood from so large an artery as the common femoral would be so great that, with whatever rapidity the operation were performed, there would be considerable risk of the patient suffering a fatal hæmorrhage, before the vessel, matted and incorporated as it would be with surrounding parts, could be separated and secured; and the ligature of the vessel would probably be followed by gangrene of the limb. The danger of a fatal result from immoderate hæmorrhage has now been completely obviated by the use of the aorta compressor.

Vessels of the Leg and Foot.—Deep stabs, cuts, and gun-shot wounds of the leg may be followed by profuse hæmorrhage from a wounded artery. It may not always be easy to determine with accuracy which of the arteries is wounded: whether it be one of the tibials, the peroneal, or only large muscular branches. This is more especially the case when, in consequence of fracture, a pulsatory extravasation of blood forms in the calf. When there is an open wound, the direction taken by it will probably enable the Surgeon to solve the question.

In the *Treatment* of arterial bleeding from the leg—whether calf or front—the Surgeon may, especially if it be not very profuse, try to arrest it by compress, bandage, and position. Should these modes fail, recourse must be had to operation.

When the **Posterior Tibial Artery** is wounded, there is no reason to deviate from the usual principle of treating a primary hæmorrhage from a wounded artery, viz., to cut down on the vessel at the seat of injury, and tie it above and below the wound on it. The same rule of treatment applies to **Wounds of the Anterior Tibial and Peroneal Arteries.** In performing this operation, if the posterior tibial be wounded in the upper two-thirds of its course, the Surgeon will have to cut freely by the side of or through the muscles of the calf. This he must do in the direction of their fibres, injuring them by transverse incision as little as possible; and, by taking the track of the wound as his guide, the bleeding vessel will at last be reached, and must then be tied in the usual way. Such an operation practised on a person with a muscular limb that is infiltrated with blood and inflammatory effusions, is in the highest degree difficult. In the lower third of the leg the arteries are superficial, and reached with comparative ease.

When the hæmorrhage is not primary, but *consecutive*, or if a diffused aneurism have formed, with or without external wound, as in the case of fracture, Surgeons have occasionally had recourse to the ligature of the superficial femoral artery, with success. The artery may be tied in Scarpa's triangle, or, what would, I think, be better in such a case, in Hunter's canal. When ligature fails, amputation is necessarily the only resource. In one of the successful cases S. Cooper ligatured the popliteal—a plan that has found favor with the French Surgeons. In another, Dupuytren tied the superficial femoral for a pistol-bullet wound in the leg. The others were cases of diffused aneurism, arising from a secondary hæmorrhage occurring in the course of a fracture.

The subject of **Wound of the Tibial Arteries** as a result of fracture of the tibia, will be more fully discussed in Chapters XX. and XXI.

Small **Circumscribed Aneurisms** are occasionally met with in the foot, in consequence of wound of one of the plantar arteries, as in operations for club-foot. If pressure have failed in preventing or curing the disease, the only course left to the Surgeon is to lay the tumor open, and to ligature the artery on each side in the usual way.

Gluteal Artery.—**Traumatic Aneurisms of the Gluteal Artery** are of less frequent occurrence than might *à priori* have been imagined, from the situation of the vessel exposing it to injury. These aneurisms may acquire an enormous size. In John Bell's celebrated case, the tumor is said to have been of "prodigious size," and to have contained eight pounds of blood. In Syme's case the tumor was as large as a man's head at the base, occupied the whole hip, and rose into a blunt cone.

The *Treatment* that should be adopted in these cases is to compress the aorta by means of Lister's tourniquet; then to lay open the tumor freely, turn out its contents, and pass a ligature by means of an aneurism or nævus needle round the short trunk of the gluteal as it emerges from the pelvis.

CHAPTER XVII.

ENTRANCE OF AIR INTO VEINS.

THE Entrance of Air into a Wounded Vein, though an accident of rare occurrence, is one that occasions such peculiar and alarming symptoms, that it becomes necessary to be acquainted with the circumstances attending it; and its study is the more interesting to the practical Surgeon, as it is chiefly in the course of operations that this condition occurs.

In surgical practice, we meet only with *spontaneous admission* of air into the circulation. This was first observed in the year 1818, in a case in which the internal jugular vein was opened during the removal of a large tumor from the right shoulder by Beauchesne. The investigation of this subject is consequently a comparatively recent matter, in which the labors of the Commissioners of the French Academy are conspicuous, and the names of Magendie, Amussat, Cormack, and Wattmann are distinguished.

RESULTS OF EXPERIMENTS ON ANIMALS.—As cases of the entry of air into the veins comparatively seldom occur in man, it is necessary to study the phenomena accompanying it on the lower animals. It has long been known to physiologists that the forcible introduction of air into the circulation would kill an animal; and Morgagni, Valsalva, Bichat, and Nysten have made this a subject of observation and experiment. The death of the animal in these cases appears to be dependent partly on the quantity of air injected, and partly on the rapidity with which it is thrown in. Bichat supposed that a single bubble injected into the circulation killed the animal with the rapidity of lightning; but this is erroneous, as shown by Nysten. I have on several occasions injected two or three cubic inches of air into the jugular vein of a dog, without producing death, though much distress resulted. The rapidity with which the air is thrown in exercises a considerable influence upon the result. If blown in quickly, a small quantity may kill; if thrown in slowly and gradually, a large quantity may be injected without destroying life, the blood appearing to absorb and carry away the gaseous fluid. In experiments which I have made on the subject, I have observed the following phenomena in cases where death was produced.

On exposing the internal jugular vein low in the neck, and puncturing it at a place where the flux and reflux of the blood are plainly discernible, there is perceived, in the first inspiratory effort made by the animal after the wound, a peculiar lapping or gurgling liquid, hissing sound; the nature of the sound depending partly on the size and the situation of the opening in the vessel. At the same time, a few bubbles of air are seen to be mixed with blood at the orifice in the vein. The entrance of the air is immediately followed by a struggle, during the deeper inspirations of which, fresh quantities of air gain admittance, the entrance of each portion being attended by the peculiar sound above described. On listening now to the action of the heart, a loud churning noise will be heard, synchronous with the ventricular systole; and the hand will, if applied to the parietes of the chest, feel at the same time a peculiar

bubbling, thrilling, or rasping sensation, occasioned by the air and blood being, as it were, whipped together amongst the columnæ carneæ and chordæ tendineæ. As the introduction of air continues, the circulation becomes gradually more feeble and languid; the heart's action, however, being fully as forcible as natural, if not more so. The animal soon becomes unable to stand; if placed upon its feet, it rolls over on one side, utters a few plaintive cries, is convulsed, extrudes the fæces and urine, and dies. If the thorax be immediately opened, it will be seen that the heart's action is continuing regularly and forcibly, and that the pulmonic cavities, though filled, do not appear distended beyond their ordinary size.

Death occurs, as I have shown in a paper on this subject, published in the 158th number of the *Edinburgh Medical and Surgical Journal*, in consequence of the air and blood being beaten up together in the right cavities of the heart into a spumous froth, which cannot be propelled through the pulmonary vessels; hence there is a deficient supply of blood to the brain and nervous centres, and fatal syncope comes on, attended usually by convulsions. In addition to this the frothy mixture in the ventricles has not sufficient resistance to press upon and to close the valves of the heart, and the organ soon comes to a stand-still.

Spontaneous Entry of Air into the Veins of Man is attended by two distinct sets of phenomena, one of a local, the other of a constitutional character.

Local Phenomena.—These consist of a peculiar sound, produced by the entrance of the air, and of the appearance of bubbles about the wound in the vein. The sound is of a hissing, sucking, gurgling, or lapping character, and never fails to indicate the serious nature of the accident that has occurred. When once heard, whether in man or in the lower animals, it can never be mistaken. It has fortunately fallen to my lot to hear this sound in the human subject on one occasion only, in a patient who had attempted suicide by cutting his throat. The wounded internal jugular was being raised for the purpose of having a ligature passed under it, when a loud hissing and gurgling sound was heard, and some bubbles of air appeared about the wound; the patient became faint, and greatly oppressed in his breathing. The ligature was immediately tightened, the faintness gradually passed off, and no bad consequences ensued.

The **Constitutional Effects** are usually very marked. At the moment of the entry of the air, the patient is seized with extreme faintness, and a sudden oppression about the chest; he usually screams out or exclaims that he is dead or dying, and continues moaning and whining; the pulse becomes nearly imperceptible, and the heart's action laboring, rapid, and feeble; death commonly results, but not instantaneously, in many cases at least. Thus Beauchesne's patient lived a quarter of an hour after the occurrence of the accident; Mirault's between three and four hours; and Clemot's several hours. Amongst the other recorded fatal cases, I have not been able to find any but vague statements as to the length of time during which the patient survived.

If the patient survive the immediate effects of the accident, he may probably recover without any bad symptoms, as happened in the case to which I have referred as occurring at the University College Hospital, and in an instance recorded by B. Cooper. The presence of the air in the pulmonic capillaries would appear in some cases to act as an irritant, and to induce fatal pneumonia or bronchitis, as happened to the patients of Roux and Malgaigne.

Cause.—The cause of the spontaneous entry of air into the veins has been very completely investigated and determined by the French Commission. If we open a large vein at the root of a dog's neck, near the thorax, in which the venous pulse, or flux and reflux of the blood, is perceptible, we shall see that air rushes in at each respiration—but only at this time—never gaining entry during expiration. This is owing to the tendency to the formation of a vacuum within the thorax, more particularly in the pericardium, during inspiration. This suction action, or "venous inspiration," is confined to the large vessels in and near the thoracic cavity, being limited by the collapse of the coats of the veins at a little distance from this. If the veins were rigid tubes, it would extend throughout the body; but as they are not, it ceases where the coats collapse. It is indeed limited to that part of the root of the neck and the axilla where the venous flux and reflux are perceptible; and the space in which it occurs has been termed the "dangerous region." But in certain circumstances, air may spontaneously gain admission at points beyond this.

It is well known that what is called by the French Surgeons the "canalisation" of a vein, or its conversion into a rigid uncollapsing tube, is the condition which is most favorable to the introduction of air into it. Indeed, except in those situations in which there is a natural movement of flux and reflux of the blood in the veins, this accident cannot occur unless these vessels be canalised, or, in other words, prevented from collapsing. This canalisation of the vessel may be occasioned in a variety of ways. Either the cut vein may be surrounded by indurated areolar tissue, which will not allow it to retract upon itself, but keeps it open like the hepatic veins; or the coats of the vessel may have acquired, as a consequence of inflammation or hypertrophy, such a degree of thickness as to prevent their falling together when divided. Then, again, the principal veins at the root of the neck have, as Bérard has pointed out, such intimate connections with the neighboring aponeurotic structures, that they are constantly kept in a state of tension, so that their sides are held apart when they are cut across. The contractions of the platysma and other muscles of the neck may likewise, as Sir C. Bell has shown, have a similar effect. In removing a tumor, also, that is situated about the neck, the traction exercised upon its pedicle may, if this contains a vein, cause it to become temporarily canalised; and the incomplete section of the vessel, especially in a transverse direction, must prevent the approximation of the sides of the incision in it, which will be rendered open and gaping by the retraction of the surrounding tissues. This patency of the incision in the veins is apt to be increased by the position that is necessarily given to the head and arm, in all operations of any magnitude about the shoulders and neck. Lastly, the introduction of air into a vein will be favored by the vessel being divided in the angle of a wound, the vein being, when the flaps that form the angle are lifted up, made open-mouthed and gaping.

In all cases in which air has gained admittance into the veins during an operation, these vessels were in one or other of the above-mentioned conditions. Thus, in Beauchesne's case, air was introduced in consequence of incomplete division of the external jugular, immediately above the right subclavian, whilst in a state of tension, during the removal of a portion of the clavicle. In a case that occurred to Dupuytren, a large vein connected with a tumor, and communicating with the jugular, was cut at the last stroke of the scalpel, whilst the tumor was being forcibly drawn up. The vein was found to be adherent to the sides of a sulcus,

so that it remained gaping when cut. In a case related by Delpech, there was hypertrophy of the axillary vein, causing it to gape like an artery. In Castara's case there was incomplete section of a vein, which opened into the subscapular whilst the tumor was being raised up. In Roux's case a vein in the neck was opened, whilst a tumor, which was being removed from that region, was being forcibly raised in order to dissect under it. Ulrick saw the accident occur in consequence of the incomplete division of the internal jugular vein, which was implicated in a tumor in the neck. A similar case happened to Mirault of Angers, the internal jugular being divided to half its extent. A case occurred to Warren, in which the air entered by the subscapular vein, the coats of which were healthy, but in a state of tension in consequence of the position of the arm; and another, in which the same accident happened from the division of a small transverse branch of communication between the external and internal jugular, whilst in a state of tension. Mott, whilst removing a tumor of the parotid gland, opened the facial vein, which was in a state of tension in consequence of the position of the patient's head, when air was introduced. A case is related by Malgaigne, in which this accident happened in consequence of the incomplete section of the external jugular vein, which was enveloped in a tumor that was being removed. Bégin also relates a case in which air entered in consequence of the puncture of the internal jugular vein whilst he was removing a tumor from the neck.

These cases, which are all that I have been able to meet with in which the condition of the wounded vein was particularised, show clearly what is the state of the vessel and of the surrounding parts that is most likely to favor the occurrence of the accident, and consequently what the Surgeon should particularly guard against in the removal of tumors about the neck and shoulders; viz., incomplete division of the veins, and the employment of forcible traction on the diseased mass at the moment of using the scalpel. In removin gtumors from the neck and shoulder, it is in many cases impossible to avoid drawing them forcibly upwards or forwards, in order to get at their deeper attachments; but if this be necessary the chest should, for reasons that will immediately be pointed out, be tightly compressed, so that no deep inspirations may be made at the moment that the knife is being used, or before a divided or wounded vein can be effectually secured.

Preventive Treatment.—In the pre-anæsthetic days, the accidental entry of air into a vein during an operation was of more common occurrence than it is now. When a patient was under the knife, the respirations were generally shallow and restrained, the breath being held, whilst every now and then there was a deep gasping inspiration; at which moment, if a vein were opened in which the pulse was perceptible, or which was canalised, air must necessarily be sucked in; and, as has already been said, in quantity and force proportioned to the depth of the inspiration. In these circumstances, the mode of guarding against the introduction of air into the veins is obvious. The chest and abdomen should be so tightly bandaged with broad flannel rollers or laced napkins, as to prevent the deep gashing inspirations, and to keep the breathing as shallow as possible, consistently with the comfort of the patient. I have often found that the entrance of air into the veins of a dog could be arrested by forcibly compressing the chest of the animal, so as to confine the respiratory movements; but that, as soon as a deep inspiratory effort was made, the compression having been removed, a rush of air took place into the vessel. If, therefore, during an opera-

tion about the root of the neck or summit of the thorax, the chest be bandaged, as here recommended, the Surgeon must be careful not to remove the compression until the operation is completed, and the wound dressed; for if this precaution be not attended to, the patient will most probably, on the bandage being loosened, make a deep inspiration, and the air may be sucked in at the very moment when all appears safe. These precautions are now rarely necessary, for under anæsthesia the respiration is usually slow, regular, and shallow. But I have retained a description of them partly on historic grounds, and partly because they may be necessary still in certain operations about the root of the neck—as the ligature of the subclavian, in which some Surgeons do not employ anæsthetics.

Curative Treatment.—Different plans have been recommended by Surgeons for the treatment of those cases in which air has already gained admittance into a vein; but, from the very fatal nature of this accident, it does not appear that much benefit has resulted from any of them: the recovery of the patient, in some of the cases, appearing to be rather due to the quantity of air that was introduced being insufficient to cause death, than to any effort on the part of the Surgeon. The two principal modes of treatment that have been recommended, consist in the *suction of the air from the right auricle*, and the employment of *compression of the chest.* Thus Amussat and Blandin advise us to introduce the pipe of a syringe, a female catheter, or a flexible tube, into the wounded vein, if it be large enough to admit the instrument; and if not, to open the right jugular, and pass it down into the auricle, and then to employ suction, so as to empty the heart of the mixture of blood and air. At the same time that this is being done, we are, say they, to compress the chest as forcibly as possible, so as to squeeze more of the air out of the heart. Magendie and Rochoux advise suction alone; and Gerdy recommends us to be content with compression of the chest. Warren (of Boston) directs us to have recourse to *bleeding in the temporal artery*, to *tracheotomy*, or to *stimulants*, according to the condition of the patient.

The indications that present themselves in the treatment appear to me to be threefold:—

1. To keep up a due supply of blood to the brain.
2. To maintain the powers of the heart until the obstruction in the pulmonic capillaries can be overcome or removed.
3. To remove, if possible, the obstruction in the capillaries of the lungs.

We shall now see how far the means already mentioned, viz., suction, compression, &c., can fulfil these indications.

Suction would no doubt be highly advantageous if we could, by this or any other means, remove the air that has gained access to the heart, and thus prevent the pulmonic capillaries from being still further obstructed. But, putting out of consideration the difficulty of finding the wounded vein; the still greater difficulty of introducing a suitable tube a suitable distance into it; the danger of allowing the ingress of a fresh quantity of air, whilst opening the sides of the incision in the vein so as to introduce the tube; and the risk there would be, if the patient recovered from the effects of the accident, of phlebitis supervening; putting aside all these circumstances, which appear to me to be the most serious objections, it becomes a question, according to Amussat, who is one of the strongest advocates of this mode of practice, whether, by suction with a syringe, or even by the mouth, any material quantity of air can

be removed. He says that, even when the tube is introduced into the right auricle, much more blood than air is constantly withdrawn. These considerations, then, should, I think, make the Surgeon hesitate before having recourse to such a hazardous mode of procedure.

The next plan, that of *circular compression of the chest*, however valuable it may be in preventing the ingress of air, can, when it has once been introduced into the veins, have no effect in removing it from the circulatory system. We cannot, by any compression that we may employ, squeeze the air out of the heart. But compression may not only be productive of no positive good, but may even occasion much mischief, by embarrassing still further the already weakened respiratory movements, and thus interfering with the due aëration of the small quantity of blood that may yet be traversing the lungs.

Bleeding from the temporal artery can by no possibility be productive of any but an injurious effect, by diminishing the already too small quantity of blood in the arterial system. *Opening the right jugular vein* may, perhaps, to a certain extent, be serviceable, by unloading the right cavities of the heart, as John Reid has shown it to be capable of doing; and it has been recommended by Cormack on this account. Lastly, *tracheotomy* cannot be of any particular service, as the arrest of the respiratory function is secondary, and not primary.

1. What, then, are the measures that a Surgeon should adopt in order to prevent the occurrence of a fatal termination in those cases in which air has been accidentally introduced into the veins during an operation? Beyond a doubt, the first thing to be done is to **prevent the further ingress of air**, by compressing the wounded vein with the finger, and, if practicable, securing it by a ligature. At all events, compression with the finger should never be omitted; as it has been shown by Nysten, Amussat, Magendie, and others, that it is only when the air that is introduced exceeds a certain quantity, that death ensues. All further entry of air having been thus prevented, our next object should be to *keep up a good supply of blood to the brain and nervous centres*, and thus maintain the integrity of their actions. The most efficient means of accomplishing this would probably be the plan recommended by Mercier; who, believing that death ensues in these cases, as in prolonged syncope, from a deficient supply of blood to the brain, recommends us to employ compression of the aorta and axillary arteries, so as to divert the whole of the blood that may be circulating in the arterial system to the encephalon. This appears to me to be a very valuable piece of advice, and to be the most effectual way of carrying out the indication. The patient should, at the same time that the compression is being exercised on his axillary arteries and aorta, or, if it be preferred, as more convenient and easier than the last, on his femorals, be placed in a recumbent position as in ordinary fainting, so as to facilitate the afflux of blood to the head. The compression of the axillary and femoral arteries may readily be made by the fingers of two of the assistants who are present at every operation of importance.

2. For the fulfilment of the second indication, that of **maintaining the action of the heart** until the abstraction in the capillaries of the lungs can be overcome or removed, artificial respiration should be resorted to as the most effectual means of keeping up the action of that organ. For the purpose of keeping up artificial respiration, Silvester's method is the best, or the Humane Society's bellows may be used; or the Surgeon may inflate with his mouth. Before inflating the lungs, it will be necessary to remove everything that compresses the chest, or interferes in any

way with the free exercise of the respiratory movements. Friction with the hand over the præcordial region, and the stimulus of ammonia to the nostrils, may at the same time be resorted to.

3. The third indication—that of **overcoming the obstruction in the pulmonic capillaries**—would probably be the best fulfilled by the means adopted for the accomplishment of the second, viz., artificial inflation of the lungs. That the action of respiration, if kept up sufficiently long, will enable the capillaries of the lungs to get rid of the air contained in them, appears to be a fact; for I have experimentally observed that, if a certain quantity of air be spontaneously introduced into the jugular vein of a dog, and artificial respiration be then established, and maintained for half or three-quarters of an hour, a very small quantity indeed, if any, will be found, on killing the animal, in the cavities of the heart, or in the branches of the pulmonary vessels. I am aware that this is not altogether conclusive of the fact, as the air might be dissolved in the blood, or might still exist in the capillaries of the lungs, although none might be found in the larger branches of the pulmonary artery; but still it seems to me that we can hardly account for the large quantity of air that will disappear when artificial respiration is kept up in any other way than that some, if not all of it, passes out of the capillary vessels into the air cells of the lungs.

CHAPTER XVIII.

SPECIAL INJURIES OF NERVES, MUSCLES, AND TENDONS.

INJURIES OF NERVES.

Contusion.—Nerves are often contused; the injury producing a tingling sensation at their extremities, and pain at the part struck. These effects usually pass off in the course of a few minutes or hours; but, in certain conditions of the system, more especially in the hysterical temperament, they may last for a considerable period, and even give rise to neuralgia of a very permanent character. In other cases the continuance of the symptoms appears to be less owing to constitutional than to local causes; apparently being due to thickening of the neurilemma, causing compression of the nerve, and thus producing a species of neuralgic paralysis of the parts supplied by it, which may become a source of nervous irritation, leading eventually to disease of the brain or spinal cord.

Puncture.—If a nerve be punctured, unpleasant consequences sometimes result, more especially in delicate women. Not only does it happen in such subjects, that the part below the puncture becomes the seat of various tingling, shooting, and burning pains, but the neuralgic condition appears to travel upwards along the proximal part of the nervous trunk. Thus, I have more than once seen a puncture of one of the digital branches of the ulnar nerve produce a kind of painful paralysis of its trunk, rendering the arm nearly useless. I have seen the same effects occur in the median nerve, from so slight a cause as the puncture of the finger by the needle. It occasionally happens in venesection at the bend of the arm, that a branch of the internal cutaneous nerve is pricked with the lancet, and that very persistent neuralgia occurs in consequence.

DIVISION.—**Primary Effects.** When a nerve is completely cut across, paralysis of sensation and motion occurs in all the parts supplied by it. Consequently, if the integrity of the nerve be essential to life, as of the pneumogastric, death must ensue. When the nerve is partially divided, or bruised as well as severed, as in cases of gun-shot injury, neuralgia in the parts supplied by it, and sometimes at the proximal end, is associated with the paralytic symptoms. The patient complains of numbness or deadness in the part supplied by it, and all tactile sensibility is lost; but various anomalous painful sensations of a burning, trickling, tingling, or creeping kind are complained of. These sensations usually give the idea of increased heat of the part to the patient, and are compared by him to the effect that would be produced by molten lead or boiling water running through it. But the sensation of heat is deceptive, for the part will be found on examination to be actually colder than natural. Thus I found in a woman who was under my care for a wound of the fore-arm, by which the ulnar nerve had been divided, that, twenty-one days after the injury, the temperature between the ring and the little finger of the injured side was 9° Fahr. below that of the same spot in the opposite hand.

The **Secondary Effects** of division of a nerve consist in various modifications of sensibility, not only in the parts supplied by it, but also in some cases, as in the instance of puncture, in the proximal part of the trunk of the injured nerve above the seat of its division. These effects, consisting of neuralgic pains and sensations of all kinds, and of varying degrees of intensity, from creeping and tingling up to real tic, are always associated with more or less paralysis, and are doubtless due in a great measure to the compression of the injured part of the nerve by inflammatory exudations, and the condensation of its sheath by plastic deposits. Besides these effects, the nutrition of the part supplied by the injured nerve becomes seriously modified. The part becomes congested, bluish, œdematous, and colder than natural. The skin becomes rough and peels, or the seat of vesicular or bulbous eruptions, which are apt to degenerate into sluggish and unhealthy ulcers. The muscles become flabby and wasted; and ultimately deformity of various kinds may ensue from the disturbance of the proper balance of antagonism between the different sets of muscles of the part.

As union gradually takes place between the opposite ends of the divided nerve, the various phenomena that have just been described gradually subside, and complete restoration of the normal sensibility, mobility, and nutrition of the part eventually takes place. In some important cases, however, this does not happen, and, the nerve about the seat of its division becoming implicated in a mass of dense cicatricial tissues, a traumatic neuroma is developed, which, just as in similar conditions in stumps, may become the seat and the source of the most intense sufferings—the neuralgic pains darting like electric shocks downwards to the terminal branches, and upwards along the trunk and the secondary divisions of the affected nerve.

Repair.—If a cut nerve be examined shortly after the injury, it will be found to have become slightly bulbous at the extremity, nervous matter having escaped from the neurilemma, and fibrine being thrown out around and between the two ends. Restoration of the continuity of the nerve evidently takes place, as is shown by the fact, that in the course of a few months its functions gradually become re-established in its lower part, the paralysis slowly disappearing. If, however, a portion of the nerve have been actually excised, there is no restoration of func-

tion, as was shown long ago by Haighton. Schwann and Hasse have found the return of sensibility and motion in the lower part of the nerve to be owing to nerve-tubes forming in the uniting medium, and thus serving to establish the continuity of the nerve.

In the **Treatment** of a cut nerve, little can be done except to lessen the sufferings of the patient; if a sensation of heat be complained of, by the application of cold; if the part be too cold, by stimulating embrocations and frictions. The neuralgia resulting from the implication and compression of a nerve by condensed cicatricial tissue has been relieved by Warren, who has dissected the nerve out of the midst of this, without dividing or otherwise injuring it.

INJURIES OF MUSCLES AND TENDONS.

Sprains or Strains of muscular parts, without rupture of fibre, are of very common occurrence, especially about the shoulders, hip and loins, and are accompanied by much pain, stiffness, and inability to move the part. When they occur in rheumatic subjects, these injuries not uncommonly give rise to severe and persistent symptoms; in some cases painful atrophy, rigidity, or local paralysis of the injured muscle being induced.

In the **Treatment** of these accidents, when recent, it will be found that kneading or rubbing the part with a stimulating embrocation, the application of dry cupping, or, if the pain be severe, the application of hot fomentations with rest is more efficient. If the injury occur in persons of a rheumatic constitution, the effects are much more severe and persistent than in those who are otherwise constituted. In such persons douches, frictions, and passive motion will, after a time, be necessary, together with proper constitutional treatment. In strumous subjects, a sprain may lead to development of very serious inflammations.

Muscles that have been sprained sometimes undergo a species of rigid atrophy, with much impairment of motion of the limb or joint. In such cases, frictions, douches, and, above all, electricity, will be found useful.

Rupture and Division.—Subcutaneous rupture of muscles and tendons not unfrequently occurs, not so much from any external violence, as from the contraction of the muscle rupturing its own substance. The rupture may occur at one of four points: in the muscular substance itself; at the line of junction between the muscle and tendon; through the tendon; and, lastly, at the point of insertion of the muscle or tendon into bone. Sédillot found that, in 21 cases, the rupture occurred at the point of origin of the tendon from the muscle 13 times; and in the remaining 8, the muscle itself was torn. It occasionally happens that the muscular sheath is ruptured, so that the belly of the muscle forms a kind of hernial protrusion through the aperture; or the tendon may be displaced by rupture of its sheath. This usually happens with the long head of the biceps, or the extensor tendons of the fingers.

These ruptures most commonly occur in middle-aged or elderly men, who have lost the elasticity of youth, though their physical strength is unimpaired. At the moment of the rupture, the patient usually experiences a sudden shock, as if he had received a blow, and sometimes hears a snap. He becomes unable to use the injured limb, and at the part where the rupture has occurred he finds a hollow or pit, produced by the retraction of the ends of the torn muscle, which contracts into a hard lump.

These accidents, though troublesome, are seldom serious. The tendo

Achillis, the quadriceps extensor of the thigh, the triceps of the arm, the biceps, the deltoid, the rectus abdominis, are the tendons and muscles that most commonly give way, with the relative frequency of the order in which they are placed.

Muscles and tendons may be cut across accidentally or purposely in almost any part of the body. In these injuries there is always a considerable amount of gaping of the wound, owing to the retraction of both ends, if a muscle be divided, and of the upper end only, if a muscle be separated from its tendon or the tendon cut across.

Union.—The mode of union of these injuries has been well described by Paget. When a tendon is cut or torn across, an ill-defined mass of nucleated blastema of a grayish-pink tint is effused into the areolar tissue and sheath, between the cut ends. About the fourth or fifth day this has become more defined and fibrillated, forming a distinct cord-like uniting mass between the ends of the tendon; in the course of two or three more days, this mass has become tough and filamentous; the tissue gradually perfects itself, until it closely resembles tendinous structure, though for some time it remains dull white and more cicatricial in appearance. The strength of this bond of union is marvellously great; Paget found that the tendo Achillis of a rabbit, six days after its division, required a weight of 20 lbs. to rupture it. In ten days the breaking weight was 56 lbs. Divided muscles unite in the same way as tendons, but less quickly, and by a fibrous cicatricial bond.

Treatment.—The principle of treatment in these cases is extremely simple: it consists in relaxing the muscles by position, so as to approximate the divided ends; and in maintaining the limb in this position for a sufficient length of time for proper union to take place. If muscular relaxation be not attended to, the uniting bond will be elongated and weak, and perhaps altogether inefficient. Stiffness and weakness are often left for a length of time—for many months, indeed—after union has taken place; very commonly, owing to the consolidation of the divided tendon to its sheath, and of this to the neighboring soft structures. Warm sea-water douches, followed by methodical friction, will greatly tend to restore the suppleness of the parts.

When the **tendo Achillis** is ruptured, the best mode of treatment consists in the application of an apparatus formed of a dog-collar placed round the thigh above the knee, from which a cord is attached to a loop in the back of a slipper; by shortening this cord, the leg is bent on the thigh, and the foot extended, so that the muscles of the calf become completely relaxed. After this simple apparatus has been used for two or three weeks, the patient may be allowed to go about, wearing a high-heeled shoe for some weeks longer.

The **Quadriceps Extensor of the Thigh** may be torn away from the insertion into the patella, or its tendon may be ruptured about an inch above this. Such an accident occurs in the same way that a patella is broken across, namely, by a violent muscular effort to prevent falling whilst the knee is semiflexed. Under these circumstances one of three things will happen; the tendon of the quadriceps, the patella, or the ligamentum patellæ, will give way. More commonly the patella is broken across; next the tendon gives way, and least frequently the ligament. When the tendon gives way the signs are unmistakable. The patient falls on the ground, is unable to raise or to stand on the injured limb, the gap occasioned by the retracted muscle can rarely be felt, and the knee-joint rapidly swells up.

The Ligamentum Patellæ is rarely ruptured. When it has given way

the patella is drawn up and a deep gap is left below it. The treatment is the same as in the case of the ruptured tendon.

The *Treatment* is that of a fractured patella, viz., elevation of the limb, supported on a back splint, in the extended position at an angle with the body. This must be continued for several weeks, when the patient may be allowed to get about with the joint protected by a knee-cap. In three or four cases of this accident which I have seen, somewhat troublesome stiffness of the parts has long been felt.

In **Rupture of the Muscles or Tendons of the Arms or Shoulder** support in a sling is all the special treatment needed. When the muscles about the shoulder are the seat of injury, rapid atrophy is apt to ensue, probably owing to the implication of the circumflex and suprascapular nerves, and consequent interference with the nutrition of the part. Fig. 136 is a good illustration of the remote effects of such a strain of the capsular muscles of the shoulder-joint. In this case the accident arose from severe dragging upon the arm by the reins of a runaway horse.


Fig. 136.—Atrophy of Capsular Muscles of Shoulder, from Strain.

In division of the **Extensor Tendons of the Fingers**—a very common accident—the hand must be kept extended in a straight splint for some weeks, until perfect union has taken place.

Laceration of the Rectus Abdominis Muscle may occur in the efforts of childbirth, or from blows upon the abdominal wall; a ventral hernia being the consequence. Guthrie relates several remarkable cases occurring in military practice, of progressive atrophy of a part of the muscular wall of the abdomen following blows.

CHAPTER XIX.

INJURIES OF BONES AND JOINTS.

INJURIES OF BONES.

A BONE may be bruised, bent, cut, or fractured.

Bruising of the Bone and Periosteum often occurs, and is usually of no great moment. A moderate contusion, however, of a bone that is but thinly covered, as the shin or elbow, may give rise to troublesome symptoms from inflammation of the periosteum. If the contusion be severe, the vitality of a layer, or even of the whole substance of the bone, may be destroyed, as happens sometimes from the graze or contusion of a bullet; or the bone may become deeply inflamed, and

suppuration take place in its cancellous structure. In old people, the contusion of a bone is frequently followed by atrophy and shortening, as happens in the neck of the femur; in strumous constitutions, it may lead to serious disease of the bone, ending in its complete disorganisation.

In the *Treatment* of bruised bone, leeches and fomentations are the most important means that we possess. The consequences will be considered when we come to speak of necrosis.

Bending of Bone may occur in two conditions, viz.: without or with fracture. Bending without fracture is most commonly met with in very young subjects, before the completion of ossification; the bone being healthy, but naturally soft, at this period of life. It occasionally takes place in an adult life, but is then the result of some structural change, by which the natural firmness of the osseous tissue is diminished. The bending most commonly occurs in the long or slender bones, especially the clavicle, the radius, and the femur, but sometimes is met with in the flat bones, or those of the skull, in which depression takes place from a blow without fracture having occurred. In many cases of bending both of long and of flat bones, there is partial fracture of the convex side—the "green-stick fracture" (see page 359).

The *Treatment* is simple: the Surgeon gradually straightens the bone, by applying a splint on its concave side, towards which the bone is pressed by a bandage and a pad applied upon its greatest convexity.

Fractures will be described in the following two chapters.

INJURIES OF JOINTS.

Contusions.—Joints are often *contused* by kicks, falls, or blows, so as to be severely injured, giving rise to much pain, and consecutive inflammation of the capsule, synovial membrane, or other structures entering into their formation. As a result of contusion the joint may be suddenly distended with blood, *hæmarthrosis*. The blood so effused undergoes absorption after a time, without leading to any inconvenience. The **Treatment** should be actively anti-inflammatory, with complete rest of the part. In a later stage, an elastic bandage, cold douches, and friction, are useful.

In some cases the **bursa**, situated in the neighborhood of a joint, is seriously bruised, and becomes inflamed: in consequence, there are often troublesome suppuration and some sloughing. When this takes place, free incision into the inflamed part, in addition to the ordinary anti-inflammatory treatment, will afford speedy and effectual relief to the patient.

Sprains.—When a joint is twisted violently so that its ligaments are either much stretched or partially torn, though there be no displacement of the osseous surface, it is said to be *sprained*. These injuries are exceedingly painful and troublesome in their consequences. They most frequently occur to the wrist and ankle-joints. The pain is very severe, and often sickening; and the sprain is rapidly followed by swelling and inflammation of the joint and investing tissues, often very chronic and tedious. As the inflammation subsides, stiffness and pain in using the part continue for a considerable length of time, and are in some cases followed by a kind of rigidity and wasting of the limb. In individuals of a rheumatic or gouty habit of body, the inflammation of the joint consequent on the sprain is often most tedious and chronic, and will only yield to appropriate constitutional treatment; and occasionally in strumous subjects, destructive disease of the joint is induced.

Treatment.—If the sprain be slight, rubbing the part with a stimulating embrocation, and giving it the support of strapping or a bandage, are all that need be done. But if it be at all severe, more active measures must be had recourse to. These must vary according to the condition of the joint when the Surgeon sees the patient; but they are all conducted on the principles of securing perfect rest, and subduing inflammatory action. If the Surgeon see the patient immediately on the occurrence of the accident, or before swelling to any great extent has occurred, the best plan is to strap up the joint very firmly with long strips of plaster, over which a starch bandage may be applied. This method of treatment, which comprises rest, perfect immobility, and compression of the joint, puts it into the best possible condition for the repair of the injured articular structures, and for the prevention of consecutive inflammation. Should inflammation with much swelling have set in, this must be subdued by keeping the joint for several hours in cold water, or well moistened with an evaporating lotion, or wet by means of irrigation or covered with ice-bags. Should this not check the inflammation, leeches may be freely applied: and, when the swelling has somewhat subsided, the joint should be supported with an elastic roller and plasters, a starched bandage, or leather splints. In the more advanced stages, when pain and stiffness alone are left, it should be well douched with cold water twice a day, and afterwards rubbed or kneaded with soap-liniment, until its usual strength and mobility are restored. This, however, very commonly does not occur in sprains of the knee and ankle for many weeks; a degree of stiffness, combined with inflammation, being left until the stretched and lacerated ligaments have regained their normal condition.

Wounds of Joints.—A joint is known to be wounded when synovia escapes from the aperture, or when the interior of the articulation is exposed. If there be any doubt as to the wound having penetrated the synovial membrane, no attempt should be made to ascertain this by probing or otherwise, as in this way the very occurrence that is to be dreaded may be induced by the Surgeon. The question of the wound having penetrated into the interior of the joint will speedily be cleared up by the symptoms that supervene.

Symptoms and Effects.—The severity of the wound of a joint depends not only on the size of the articulation, but on the nature of the wound, and the age and health of the patient.

Surgical wounds of joints for the purpose of removing loose cartilages may usually be made with perfect safety, if proper precautions be taken to prevent the intrusion of air. So also there are many cases on record in which joints have been opened for the removal of foreign bodies—as needles—and perfectly movable articulations left.

But with joints laid open as the result of accidents, the consequences are usually not so favorable. This may be owing to many causes, such not only as the free admission of air, but also of dirt and foreign bodies likely to excite inflammation.

When a small joint, as that of one of the fingers, is opened, the injury may often be recovered from, without destruction of the articulation. When a large joint is opened, even by a small incised or punctured wound, there is great danger lest such extensive local mischief and constitutional disturbance should ensue as to lead to the destruction of the articulation, with danger to the patient's life. When the wound is large, lacerated, or contused, with fracture of the articular ends of the bones, one or other of these consequences will certainly follow. It is especially

in adults that these unfavorable results ensue; in children, extensive injuries of large joints may heal favorably; though, if the child be of a strumous habit, destructive action is apt to be set up.

Traumatic Arthritis.—The source of danger in a wounded joint is the inflammation set up in the articulation. A few hours after the infliction of the injury the joint swells, becomes hot and painful, and throbs. If, under proper treatment, resolution be effected, these inflammatory symptoms will gradually subside, leaving the articulation weak, tender, and stiff for some considerable time. Should, however, the inflammation continue, the pain increases, becoming tensive and excessively severe. If the aperture be large, synovia freely escapes, which soon becomes mixed with inflammatory products. If it be small, little more than a puncture, the joint swells, and fills with purulent fluid, which will either escape through the original wound, or find an outlet for itself through a new opening. There are starting in the limb, which is flexed, with excessive pain in any attempt at moving it. The constitutional disturbance becomes very severe, the patient being occasionally carried off by the violence of the irritative fever. In other cases symptoms of purulent absorption come on, and death results from pyæmia.

If the patient survive this period of acute action, abscesses may form around and above the articulation; and the discharge from these, as well as from the joint, induces irritative fever and hectic. Should this danger be passed through, and the patient eventually survive, it will be with a partially ankylosed limb, the utility of which is greatly impaired.

The severity of the symptoms in the wound of a large joint is evidently dependent on the extent and depth of the synovial membrane which suppurates, wounds of ginglymoid being hence more dangerous than those of orbicular joints; and on the retention of the pus thus formed, or its imperfect exit from the midst of the tense and unyielding tissues. The admission of air into the joint is of itself a great source of danger, though not necessarily of destructive disorganisation. Its danger is well shown by the fact that, in the most extensive subcutaneous wounds and lacerations of joints, such as occur in dislocations and simple fractures in which the capsule is widely torn, the ligaments ruptured, the incrusting cartilages and synovial membranes broken through, and the interior of the joint filled with blood, suppuration never takes place, but the lacerated joint-structures heal kindly and well in a few weeks, leaving the articulation almost unimpaired in its movements. The presence of air appears to exercise an injurious influence upon the pus collected in the depths of the joint, causing it to become putrescent and acrid, and thus greatly increasing the local irritation. It is this retention of acrid and putrescent pus, in contact with a large inflamed surface, that gives rise to ataxic fever and pyæmia, which so frequently prove fatal in these injuries. Of all wounds of joints, gun-shot injuries are necessarily the worst. In these, the aperture cannot possibly be closed and united by the first intention; it and the track of the ball must suppurate. The bones are also usually splintered, and foreign bodies of various kinds are introduced into the articulation; hence the most extensive disorganising and fatal mischief commonly ensues.

Traumatic arthritis differs from the destructive and disorganising idiopathic inflammations of joints in this: that, when the inflammation occurs as the result of a wound, the synovial membrane is the part primarily affected; if the cartilages become involved, they are so secondarily; the articular ends of the bones not participating in the morbid action. When a joint is the seat of disorganising inflammation of an

idiopathic character, the mischief usually commences in the osseous articular ends, or in the cartilage, the synovial membrane being often the last affected. In the traumatic form, the disease may be said to radiate from the centre of the joint; in the idiopathic, to proceed from the circumference.

In recent cases of traumatic arthritis we find the synovial membrane lustreless, swollen, tufted, infiltrated, gelatinous in appearance, of a crimson color, and covered with lymph; the contiguous or subjacent portions of cartilage are softened and partially eroded. Under the microscope, a disruption of the cartilage-cells may be observed, and the intervening substance is granular; these changes gradually cease in deeper sections of the cartilage, which will be found to present a healthy appearance. In the more advanced stages of the disease, when the joint has been suppurating perhaps for months, it will be found that the synovial membrane is deeply vascular in places, in other parts pulpy and infiltrated with, or replaced by, greyish or yellowish plastic matter. The cartilages are eroded in patches exposing the rough and injected surfaces of the articular extremity of the bone; where not eroded, they are pulpy and disorganised. Occasionally partial but unsuccessful attempts at bony union will have been set up between the opposite exposed osseous surfaces.

In the **Treatment of Wounded Joints**, the first point to be determined must be whether amputation or resection should be performed, or an attempt made to save the injured joint. If the joint be small, and the disorganisation of bones or soft parts not very great, there can be no doubt that we ought to attempt, and shall usually be able to save it. But if it be of one of the larger articulations, the line of practice must be determined by the extent of the injury, and the age and constitution of the patient If the wound be but small and clean cut, no Surgeon would be justified in having recourse to immediate amputation, even though it be the knee that is injured. But if the joint have been extensively laid open, with much contusion and laceration, complicated perhaps with dislocation, or with fracture and splintering of the bones, the case is different. In these unfavorabe circumstances, however, in the upper extremity, and even in the ankle, the limb may not unfrequently be saved. If the bones be comminuted, the removal of splinters and resection of the articular ends may advantageously be practised in many cases, more particularly if the patient be young and sound in constitution, and the soft parts not too extensively damaged. But if these be largely lacerated and widely contused, and the patient aged or broken in health, amputation is imperatively called for. This is more especially the case when the knee is injured; extensive lacerations of this joint more particularly when complicated with dislocation or comminution of the bones, being cases for early amputation.

If it be determined to make an attempt at saving the joint, the principal point is, if possible, to close the wound by the first intention, and thus to prevent suppuration. With this view the antiseptic method has been employed with excellent results, even in cases of severely wounded joint. After removing foreign bodies, splinters, &c., the wounded articulations must be well washed out with carbolic acid lotion (1 to 40), and the dressings applied with minute attention to detail, as described at p. 216.

Should antiseptics not be used, the following treatment should be adopted. If the joint be opened by a puncture, or small clean-cut wound, this may occasionally be closed by bringing the edges together, and

placing a piece of lint soaked in collodion upon it, or a strip of plaster washed over with resin varnish. The joint must then be placed in a splint (plaster of Paris is the best), so as to be rendered absolutely immovable, and should then be surrounded by India-rubber bags containing pounded ice. In fact, the three great principles of treatment in the early stages of wounds of joints consist in the exclusion of air, perfect rest, and the continuous application of dry cold. In this way inflammatory action may be prevented, and the union of the wound may take place under the plaster; but in the majority of cases the injury is followed by so abundant a secretion of synovia, that the dressing becomes loosened by the tension and outward pressure of the accumulated fluid which escapes from under it. If the preventive means of arresting inflammation fail, and the joint swell, becoming red, hot, and throbbing, with much constitutional irritation, means should be taken to limit the inflammatory action. This is best done by the free application of leeches over the joint, hot fomentations, and the internal administration of calomel and opium about four times in the day. This remedy possesses a more decidedly controlling influence over traumatic arthritis than any other with which I am acquainted.

When suppuration has come on, long and free incisions should be made into the joint so as to procure an early outlet for the pus; the part must be well poulticed, and an attempt made to procure ankylosis by the granulation and cohesion, through fibrous tissue, of the articular surfaces. Puncturing the joint is worse than useless. By a puncture, the pus cannot be evacuated from a deep and complicated joint, but air is admitted, and the result is decomposition of secretions, with irritative fever and pyæmia; but, by making free and early incisions, the dangers resulting from decomposition of the pus and its absorption into the system are in a great measure lessened, and the constitutional irritation produced by the tension of the parts is at once removed. The joint itself is not put in a worse condition by being more freely opened; for, when once suppuration has been set up in it, even to a limited extent, destruction of its tissues must ensue; and the patient may recover with a stiff joint, or amputation may become imperative, or he may die from constitutional irritation. The most favorable result that can be anticipated, therefore, is a stiff joint, and this the Surgeon should endeavor to obtain. If the case proceed favorably, the discharge will gradually lessen, and the constitutional disturbance subside. The joint must then be placed in such a position, that, when ankylosis results, the limb may be serviceable to the patient. If, however, as very frequently happens when the larger joints are wounded, the suppuration within the articulation, and the abscesses that form outside it, reduce the patient to a hectic state, secondary amputation speedily becomes inevitable.

Wounds of Individual Joints.—To the preceding general principles I have little to add with respect to wounds of the individual joints.

The **Hip and Shoulder** are so deeply placed, and so well protected that they can scarcely be wounded except as the result of gun-shot injury, the treatment of which condition has already been discussed (pp. 250, 251).

Wound of the **Knee-joint** is one of the most common and most severe of such injuries. When the result of gun-shot violence, it imperatively demands immediate amputation. When produced by a puncture or clean cut, the wound must be closed, and ice and antiseptics employed assiduously. Should suppuration occur, the joint must be freely laid open by long incisions, and commonly amputation will be

required. The abscess will often form deeply in the thigh rather than in the joint itself; and in a very insidious manner. The limb swells up to the trochanters, becomes very tense, painful, hot, and œdematous, with great constitutional disturbance and irritative fever. But the joint may be but little swollen, and many days will often elapse before fluctuation can be felt in it or in the thigh. It is this absence of swelling in the knee itself that may mislead an inexperienced practitioner. At length the abscess may approach the surface near the knee; and, on an incision being made, an immense quantity of pus is discharged. The abscess forms as a consequence of the escape of some of the irritating contents of the suppurating synovial membrane, close upon the anterior surface of the femur; it creeps up and surrounds the bone under the deep muscles of the limb, which are separated from the bone, and may reach as high as the trochanters before it is detected. It is this depth in the limb at which the abscess is seated that gives rise to the difficulty in its detection, the violent constitutional disturbances it occasions, and its extreme danger. I have never seen abscess form amongst the muscles of the leg as a consequence of injuries of the knee-joint, unless the tibia had been fractured as well as the joint opened.

For the penetration of the knee-joint by needles, see p. 233.

Wounds of the **Elbow** and **Ankle-joints**, when simple, as in punctures, usually admit of closure and of being healed, leaving a sufficiently useful and mobile articulation. When they are complicated with fracture of the neighboring bones, the soft parts not being too extensively injured, resection of the injured articulations is the proper course to adopt, followed by antiseptic dressings and good drainage; if there be much laceration of soft parts with comminution of the bones, amputation, especially in the case of the ankle, will be required.

Wounds of the **Wrist-joint** are peculiarly dangerous, on account of the extent and complexity of the synovial membrane that enters into its conformation. Should suppuration be set up, some of the carpal bones may necrose, and thus amputation may be rendered imperative; or, if this be averted, a stiff and comparatively useless hand will be left.

DISLOCATIONS will be described in Chapter XXII.

CHAPTER XX.

FRACTURES.

THE management of Fractures constitutes one of the commonest duties of the Surgeon, and hence the consideration of all that relates to their nature and treatment is of the utmost importance.

A fracture may be defined as a sudden and violent solution of continuity in a bone; but by the term fracture it is convenient to describe other lesions, which, strictly speaking, are not comprised in the definition. The displacement of an epiphysis from the shaft of a bone is not really a *fracture* but a *separation;* as is also the displacement of a costal cartilage from a rib.

CAUSES.—Fractures are almost invariably the result of local causes, but the liability to their occurrence is more or less modified by certain predisposing circumstances.

Local Causes.—Fractures may occur from the application of external violence, or from muscular action.

External violence may be applied in two ways: directly or indirectly.

The worst forms of fracture are occasioned by **direct external violence**, the blow crushing and splintering the bone, as by the passage of a heavy wheel or a gun-shot injury. When the bone is broken by direct violence, the fracture is always at the seat of injury, and is often complicated with considerable mischief to the soft parts, the result of the same force that breaks the bone.

Indirect violence may break a bone in two ways. One that is more commonly talked of than seen is by *contrecoup*, in which, when a blow is inflicted on one part, the shock that is communicated expends its violence on the opposite point, where the fracture consequently occurs. This form of injury is chiefly met with in the head; and, although its occurrence has been denied, I cannot doubt it, as I have seen unequivocal instances.

In the next form of indirect violence occasioning fracture, the bone is broken by being snapped, as it were, between a resisting medium on one side, and the weight of the body on the other. Thus, a person jumping from a height and alighting on his feet, may break his legs by their being compressed between the weight of the body above and the ground below. The long bones are those which are most frequently fractured in this way; and the fracture occurs at the greatest convexity, or at their weakest point. When a person jumps from a carriage that is in motion, although the height of the fall be not great, yet its force is considerable, the feet coming violently to the ground, while the body moves with the same velocity as that with which it was being carried onwards in the vehicle. Hence, fractures received in this way are usually severe, and often compound or comminuted.

Muscular action is not an unfrequent cause of fracture of those bones into which powerful muscles are inserted. This is especially the case with the patella and some of the bony prominences, such as the acromion, which are broken in the same way that a tendon is ruptured —by the violent contractions of the muscles attached to them tearing them asunder. It is not often that the long bones are so fractured; but the humerus has been broken by a person striking at but not hitting another, or by suddenly throwing out the arm to seize something that was falling; and the clavicle has been fractured by a rider giving his horse a back-handed blow. In these cases, however, muscular action may not have been the sole cause, the weight of the limb also tending to fracture the bone. Those bones that do not afford attachment to any powerful muscles, as the cranial, for instance, cannot be fractured in this way.

Predisposing Causes.—These are numerous and varied.

Some bones are especially liable to be broken in consequence of their *serving as points of support*. Thus, when a person falls upon the hand, the shock is transmitted from the wrist-joint through the radius, humerus, and clavicle, to the trunk; the radius and clavicle, being the weaker bones, are then especially liable to be fractured. So again, the *situation* of a bone, irrespectively of any other circumstance, may predispose it to fracture; the prominent position of the nasal bones, and the exposed situation of the acromion, render these parts peculiarly liable to this injury. The *shape* of some bones disposes them to fracture; thus, a long bone is necessarily more readily broken than a short and thick

one; hence fractures of the tibia and femur from falls on the feet are more common than of the os calcis. *Certain parts of bone* are more commonly fractured than others. Those parts especially into which powerful muscles are inserted, or that are in exposed situations, and hence liable to injury, or have to receive the weight of the fallen body, are often broken. Hence the acromion, the olecranon, and the neck of the femur, are commonly fractured.

Age exercises considerable influence, not only on the general occurrence of fracture, but on the peculiar liability of certain bones. Though fractures may occur at all ages, even in intra-uterine life (Chaussier has dissected a fœtus that had 113 fractures), yet bone, being elastic and cartilaginous in early age, is less readily broken than when it has become brittle and earthy, as in advanced life. In children, fractures most commonly occur at the point of junction between the shaft and epiphysis, where ossification has not as yet become perfect. This separation of the epiphysis in children, the detachment, as it were, of the terminal points of ossification, occurs chiefly at the lower ends of the humerus and femur, sometimes in the radius and other long bones. As age advances, the compact tissue of the shaft becomes denser and harder, but the cancellous structure of the extremities more dilated and looser; hence fracture of the neck of the femur is especially common in old people. In young persons also, the bone is usually simply broken transversely, but fractures taking place at a more advanced period of life are generally oblique, and often comminuted; in adults they also more commonly extend into joints than when occurring in early age. From statistical tables of fractures of the upper limb given by Flower, it appears that below five years of age the liability of the two *sexes* to fracture is equal. After five, the males steadily increase in liability up to middle life. After forty-five, the number of fractures in females exceeds that in males, in consequence of the extreme frequency of fracture of the lower end of the radius in women above middle life. In children, more than one-half the fractures occurring in the upper limb are of the clavicle.

Fracture termed **Spontaneous** sometimes happens without any very direct cause, or under the influence of violence that would usually be insufficient to occasion it. This may happen in consequence of the texture of the bone being weakened or rendered brittle by disease, such as mollities or fragilitas ossium, by the cancerous cachexy, by syphilis, by cancerous growths within the substance of the bone, or by the pressure of some neighboring tumor causing absorption. In other cases, again, it occurs without any apparent disease, local or constitutional. This usually happens as the result of the brittleness and weakening induced by age. I have known a gentleman little above fifty, apparently in perfect health, break his thigh with a loud snap whilst turning in bed. In these cases union rarely takes place, or not without much difficulty. But spontaneous fracture of the femur has more than once been met with in young men apparently quite healthy, from the sudden and violent contraction of the thigh muscles, as for instance in pulling off or drawing on a boot. As a rule, union readily takes place.

Sex indirectly influences the liability to fracture, men being more frequently exposed to the causes of this injury than women. In women, the bones that are most commonly fractured are the clavicle, the tibia, and the neck of the femur; in men, the shafts of the long bones, the cranium, and the pelvis.

From statistical accounts it would appear that the right limbs are

more frequently broken than the left, being more exposed to violence. The supposition that the bones are more brittle in winter, and hence break more readily than at other seasons, is altogether a mistake; though fractures may be common at this period of the year, from falls being more frequent.

VARIETIES.—Fractures present important varieties as to their *Nature* and their *Direction.* The varieties as to nature depend upon the cause of the fracture, its seat, and the age of the patient.

Nature.—Fractures are divided into two great classes, according as they are unaccompanied or attended by an open wound leading down to the line of breakage in the bone—the first being called *Simple*, the second *Compound.* In the first class are included the **Simple Fracture**, where the bone is merely broken across, split or fissured; the **Impacted**, where one fragment is wedged into another, the compact tissue being driven into the cancellous structure; the **Comminuted**, where the bone is broken into several fragments; and the **Multiple**, where there are more fractures than one.

When the soft parts are torn through, so that the fracture communicates by a wound with the surface of the body, it is said to be **Compound.** A fracture may be rendered compound in two ways: either through laceration of the soft parts by the same injury that breaks the bone, as when a bullet in traversing a limb, fractures the bone; or else by the protrusion of one of the extremities of the broken fragments through the integuments. This necessarily most frequently happens when the fragments are sharp and pointed, and the coverings thin, as in fracture of the tibia, and may be occasioned by muscular contraction, or by some incautious movement on the part of the patient, driving the fragment through the skin.

It is important to distinguish between fractures that are primarily compound, that is, that are compound from the first or become so within a few days, and those in which a wound leading to the broken bone forms some time after the accident, as the result of inflammation, suppuration, and sloughing, or from other causes. When the fracture becomes compound secondarily, the danger is greatly lessened, on account of the reparative tissue that has formed at the broken ends of the bones closing up the medullary and Haversian canals, and by that means diminishing the risks of severe inflammation of the bone, pyæmia, and the absorption of septic matters.

A fracture is said to be **Complicated** when the injury to the bone is conjoined with other conditions which are perhaps of more importance than the mere fracture, the complication constituting often the most serious part of the injury, and influencing greatly the general result of the case. Thus, a fracture may be complicated with injury of an important internal organ, as of the brain, lungs, or bladder; the injury to the organ being inflicted by the projection against it of one of the broken fragments. A fracture is not infrequently complicated with the wound of one of the principal arteries of the part, as happens especially in the leg, where the tibial arteries, being in close contact with the bone, are often torn by the broken ends. In other cases, again, the fracture is associated with injury of a joint or with dislocation.

Besides these varieties of fracture, it occasionally happens that a bone is only cracked, or partially broken. This especially occurs in the bending of bone in children, in which cases the fracture may be **Partial** or **Incomplete**, merely extending across the convexity of the curve made by the bone. This is sometimes called the "*green-stick*" fracture.

Direction.—The direction assumed by fractures varies greatly, and depends materially on the cause of the injury, as well as upon the bone that is fractured.

The line of fracture may run through a bone in three different directions: either *transversely*, *obliquely*, or *longitudinally* to its axis.

The **Transverse Fracture** is the simplest, and is seldom complicated with injury to the neighboring parts. It chiefly occurs in children, and very frequently between the articular extremity and the shaft of a bone; it unites readily, and is attended by but little displacement. It is most commonly the result of direct violence, but it may arise from muscular action, as in the case of the patella, which is usually broken in this way.

The **Oblique Fracture** commonly occurs from indirect violence; the breaking force being applied to the ends, and not across the shaft. It often runs a long way, more than half the distance of the shaft of a bone, and is more dangerous than the transverse, owing to the obliquity of the fracture causing the ends of the bone to be sharply pointed (Fig. 137, *a*), and thus frequently to puncture the skin, or to perforate an artery. It is more tedious in its cure than the transverse, owing to the extent of surface over which the process of repair has to be carried on, and the difficulty of keeping the fragments directly in apposition; hence, also, there is a greater liability to shortening of the limb. It is principally met with in the shafts of the long bones of adults and elderly people.

Fig. 137.—Oblique and Longitudinal Fractures.

The **Longitudinal Fracture** consists of a splitting or fissuring of a bone in the direction of its axis (Fig. 137, *b*). Longitudinal fracture, or splitting of bone, is not very common in civil practice; but in military practice it is frequent, especially from the action of conical rifle-balls. In such cases, when the shaft is struck and shattered, the splitting of the bone may extend widely in either direction—sometimes into the neighboring joint (Fig. 85, p. 237), although, as Stroymeyer has remarked, it usually stops short of this, terminating at the epiphysis. When the fracture is produced by a blow, which need not be a very severe one, upon the articular end, the bone may be split and the joint opened.

The Separation of the Epiphysis of one of the long bones from the shaft, at the line of junction, is an accident that occasionally occurs in children and young people at any period up to that of the completion of the ossification between the parts. Hence it is usually met with under the age of 21 or 22. This kind of fracture is always transverse. It is apt to simulate a dislocation very closely; but the diagnosis may be made by finding that the articulation is always intact, and its movements usually free. Union by bone readily takes place. Not only are the epiphyses of the long bones liable to this separation through the line of junction, but the same thing may happen to various processes, as the acromion, olecranon, &c.; and some osseous structures, as the acetabulum, and sternum, are apt under external violence to separate into their original component parts.

Signs.—Fracture may produce pain, and alteration of the bulk of the limb; these may be due either to the laceration of the soft parts by the broken fragments, or to the general injury inflicted upon it. Increase of size is observed in some cases of fracture; the augmented size being due

either to the extravasation of blood into the limb, which often takes place to a very considerable extent, even without the wound of any principal vessel; or to the approximation of the attachments of the muscles by the shortening of the limb. Diminished bulk, or flattening, occurs in some cases, in consequence of the weight of the limb drawing the part down, and thus lessening natural rotundity. Neither pain nor alteration of bulk can be regarded as pathognomonic of fracture.

The more special and peculiar signs of fracture are three: 1. A change in the Shape of the Limb; 2. Mobility in its Continuity; and 3. The existence of Grating between the Broken Ends of the Bone.

1. The **Change in the Shape of the Limb**, due to the displacement of portions of the broken bone, is perhaps the most important sign of fracture; it manifests itself by a want of correspondence between the osseous points on opposite sides of the body, by an increase or diminution of the natural curves of the limb, by angularity, shortening, or swelling.

In investigating the existence and extent of displacement in a case of fracture, the Surgeon should always strip his patient, and compare the corresponding points of bone on the opposite sides of the body, and their relative situation to some fixed and easily distinguishable neighboring prominence on the trunk or injured part of the limb. From this the measurements may be taken, by grasping the injured part and the corresponding portion of the healthy limb in each hand, and running the fingers lightly over the depressions and elevations, marking any difference that exists; or, if greater accuracy be required, measuring by means of a tape. In some cases the measurement must not be made between the trunk and the limb injured, or even from the extremity of the limb to the other, as shortening of the whole member might depend on other causes than fracture, such as wasting, disease of joints, or dislocation; when this is the case, the measurement must be taken between different points of the bone injured, and compared with a similar measurement of the sound limb.

The displacement of a broken bone may be the direct result of the violence which occasions the fracture, the fragments being driven out of their position, as when a portion of the skull is beaten in; or it may result from the weight of the limb dragging downwards the lower fragment, as in a case of fractured acromion. In some cases it is either occasioned or greatly increased by the direction of the fracture. Thus, in several cases of broken tibia which have been under my care, the line of fracture being oblique from above downwards, and from before backwards, I have found the upper end of the lower fragment project considerably forwards, sliding, as it were, along an inclined plane in the upper fragment; and in one of these cases, which I had an opportunity of dissecting after amputation, the direction of the fracture, rather than muscular action appeared to be the cause of displacement. In transverse fractures there is always but slight displacement.

Muscular contraction is, however, without doubt the most active cause of displacement: hence it has been found that, in paralysed limbs which are fractured, there is but little deformity. The contraction of the muscles of the part approximating their points of attachment, owing to the support or resistance offered by the bone being removed, draws the most movable fragment out of its normal position. The other causes that have just been mentioned, tend greatly to favor this kind of displacement; but in some cases, as in fractured patella, the displacement is entirely

muscular, and in all fractures of the long bones it is chiefly due to muscular contraction.

The **Direction of the Displacement** is principally influenced by the direction of the fracture, the position of the limb, and muscular action; it may be angular, transverse, longitudinal, or rotatory.

In the *angular* displacement there is an increase of the natural curvature of the limb, the concavity of the angle being on the side of the most powerful muscles; thus, for example, in fracture of the thigh, the angle projects on the anterior and outer side of the limb, because the strongest muscles, being situated behind and to the inner side, tend, by their contraction, to approximate the fragments on that aspect. This displacement principally occurs in oblique and comminuted fractures.

The *transverse* or *lateral* displacement occurs when a bone is broken directly across, the fragments often hitching one against another, and so being, as it were, entangled together. In this case there is often but very little deformity.

In the *longitudinal* displacement there may be either shortening or elongation of the limb. When there is shortening, as most commonly happens in oblique fractures, it is dependent on muscular contraction, the broken ends of bone being brought together so as to overlap one another, or on "riding." In other cases, the shortening may be owing to the impaction of one fragment in the other. In some cases there is preternatural separation of the fragments, the weight of the limb tending to drag the lower one downwards, or muscular contraction drawing the upper one away from it.

The *rotatory* displacement is owing to the contraction of particular sets of muscles twisting the lower fragment on its axis, as well as producing shortening of the limb. Thus, the external rotators in intracapsular fractures of the neck of the thigh-bone, and the supinators in some fractures of the radius, have a tendency to twist or rotate the lower fragment in an outward direction.

2. The occurrence of **Preternatural Mobility in the Continuity** of a bone cannot exist without fracture, and separation of the fragments from one another; hence, its presence may always be looked upon as an unequivocal sign of broken bone. But fracture may exist without it; thus, it occasionally happens that fracture takes place, and, owing to the impaction or wedging together of the fragments, mobility is not perceived.

3. Another sign of much value in practice is the occurrence of **Crepitus**, or rather of the **Grating together of the Rough Surfaces of the Broken Bone**, which can be felt as well as heard on moving the limb. This grating can only occur when the fragments are movable and in contact, and is especially perceptible when the rough ends of the broken bone are directly rubbed against one another. It is not, however, an invariable accompaniment of fracture; being absent in some cases, in which the fracture is firmly impacted, or when the fragments are widely separated. It must not be confounded with the crepitation that occurs in the limbs from other causes, as from emphysema, or from the effusion of serous fluid into the sheaths of the tendons, which gives rise to a peculiar crackling sensation, very different from the rough grating of a fracture.

It will thus be seen that each of these three signs, taken individually, is more or less equivocal, and that it usually requires a combination of at least two of them to determine whether fracture exists. In ascertaining the existence of a fracture, the Surgeon should make the necessary

manipulations with the utmost gentleness, but yet effectually, so that no uncertainty may be allowed to remain as to the seat and nature of the injury, more especially when it occurs in the vicinity of the joint. The increased mobility may be ascertained by fixing the upper fragment and rotating the lower portion of the limb; the grating by drawing down the lower fragment, so as to bring the rough surfaces into apposition, and then grasping the limb at the seat of fracture with one hand, and rotating it gently with the other. The displacement must be ascertained by measuring the limb carefully in the way that has been directed, and by comparing the injured with the sound side.

Diagnosis.—The diagnosis of an ordinary fracture is seldom attended by any material difficulty. The co-existence of displacement, of abnormal mobility, and of grating, will usually enable the Surgeon at once and readily to pronounce with certainty its existence, when it is *simple.* When it is *compound*, there is frequently the additional evidence afforded by the protrusion of the end of one of the fragments; and it it be *comminuted* as well, the loose splinters will be readily felt.

There are, however, two conditions that render the detection of a simple fracture occasionally difficult. The first is, when only one of two or several contiguous bones is broken; the other, the impaction of the fragments.

When only one bone is broken in a situation where there are two or more, as in the leg, forearm, metacarpus or metatarsus, very close and careful manipulation of the injured bone may be required. The Surgeon must run his finger carefully over the most projecting ridge, feel for slight inequality or œdema at one part, or perhaps he may elicit the faintest occasional crepitus on fully and deeply moving the bone at the seat of suspected frature.

In the case of impaction the diagnosis is even more difficult. Here no crepitus, and no preternatural mobility, can be found; but the Surgeon must be led to his diagnosis by the recognition of the peculiar displacement and distortion which may be characteristic of the particular fracture, as, for instance, the deformity of the wrist in impacted fracture of the lower end of the radius.

The difficulties of diagnosis in fracture of a single bone, or in an impacted fracture, are necessarily most seriously increased if there be much extravasation of blood into the limb; or, when the fracture is through an articulated end, if there should be much effusion into the neighboring joint.

As has already been stated, the existence of a fracture when *compound*, and more particularly if *comminuted*, is usually readily determined. Here, the great mobility, the protrusion of fragments or splinters, and the ready crepitus, will seldom allow the Surgeon to be in error. Should any doubt exist, the introduction of the finger into the wound will enable him to determine with certainty, not only the existence, but the condition and extent of the fracture. But with all the assistance that may thus be afforded, the very existence of a bad compound and comminuted fracture may be unsuspected for many days, even though most careful examinations have been made with the view of ascertaining its presence. Of this important fact, which may have weighty bearings in medico-legal investigations, the following case is a good illustration. A young man was shot with a wooden ramrod through the left hand and shoulder, by the accidental explosion of his gun whilst he was loading it. The ramrod struck the humerus three inches below the shoulder-joint, full on its fore part. It was splintered against the bone, the fragments passing on

each side, and mostly escaping through two apertures of exit posteriorly; some passing to the inner side between the large vessels and the bone, the others to the outer side between it and the deltoid. The patient was brought to the Hospital, where I saw him a few hours after the injury, and, enlarging the wounds, extracted a number of splinters of the ramrod from around the bone. The limb was carefully examined, not only by me, but by several other Surgeons present, to determine whether the bone has been fractured, or the joint injured. There was no sign of fracture to be detected—no shortening, no mobility, no crepitus, no inequality when the fingers were freely passed into the wounds, no displacement at all. As no fracture appeared to exist, the limb was laid on a pillow, and irrigation employed. Erysipelas set in, followed by extensive and deep suppuration in the limb. On examining this, with the view of giving a free exit to the discharges, eight days after the accident, displacement and crepitus were for the first time found, and it became evident that the humerus had sustained a comminuted fracture. The patient died of pyæmia; and after death the bone presented the appearance here given (Fig. 138), a long splinter having been detached in a longitudinal direction, A B, and the shaft broken across at C. Here, then, was not only a compound, but a comminuted fracture, detected for the first time a week after the infliction of the injury. It appeared probable that the blow of the ramrod had fractured the bone longitudinally, detaching the large splinter, which had become impacted; and that the shaft still held together by a narrow bridge of bone at C, which being broken across subsequently in moving the limb, now become heavy by inflammatory infiltration, led to the shortening of the limb and the lateral displacement of the fragments.

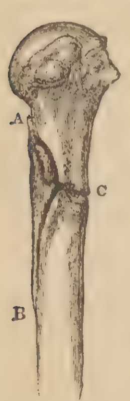


Fig. 138.—Comminuted Fracture of the Humerus without displacement.

Union of Fractured Bone.—A fractured bone is ultimately united by being soldered together by the deposition of new bone around, within, and lastly between the broken fragments. In exceptional cases, as in fractures occurring within the capsule of a joint, and in those of the patella and the olecranon, union is effected by fibrous or filamentous tissue. In some instances that will hereafter be considered, owing to peculiar local or constitutional circumstances, new bone is not formed, but the uniting medium is fibrous.

The new bone that constitutes the bond of union is termed **Callus**. In many cases a larger quantity of this is temporarily deposited than is permanently left. This temporary formation of bone goes by the name of the **provisional callus**. It is formed partly external to the fracture, incasing the broken ends, and partly in the medullary canal, so as to include the fragments between layers of new bone, and thus maintain them in contact. That which is permanently left, and which intervenes between the broken ends, is called the **definitive callus**. The process of union varies somewhat in simple and in compound fractures.

Union of Simple Fractures.—The production of callus has been studied with much care by Haller, Duhamel, Bordenave, and Hunter, by Dupuytren, Breschet, and Villerme, and more recently by Stanley, Paget, and Billroth. From the observations of these pathologists, it would appear that the union of a broken bone takes place through the medium of plastic matter, deposited by a process of adhesive inflammation set up in the injured bone itself, in its periosteum, and the neighboring soft

parts; the lymph thus formed gradually undergoing development into osseous tissue. The whole process, indeed, is strictly analogous to that which takes place in the ordinary healing of a wound by adhesion and the development of the cicatricial tissue. The broken fragments are at first movable, and surrounded by a considerable extravasation of blood. In the course of ten or fourteen days, this has ordinarily undergone absorption to a considerable extent; the periosteum and the medullary membrane in the vicinity of the fracture, the tissues around it, and the broken bone itself, become very vascular, and pour out a quantity of lymph between and around the fragments, as well as within the medullary canal, so that the fractured ends are ensheathed by a reddish gelatinous mass of a fusiform shape, thickest opposite the seat of injury. This gradually becomes more and more consolidated; and, in proportion as it becomes firmer, the mobility of the fragments lessens, and, the ends of the bone becoming smooth by the plastic deposit being adherent to and interposed between them, grating is less distinct. From the third to the fourth week the lymph has assumed a sufficient degree of firmness to keep the fragments in apposition, though the bone still yields readily at the seat of fracture (Fig. 139). This lymph, which is poured out not only by the periosteum and bone, but by all the soft parts in the neighborhood of the fracture, gradually undergoes ossification, the bony matter being first deposited in a granular manner, but in sufficient quantity by the sixth or eighth week to unite the fracture rather firmly. The callus, which is at first soft and spongy, and differs from old bone in its microscopic as well as ordinary physical characters, gradually assimilates to old bone, both in hardness and in structure, osseous corpuscles and vascular laminated canals being formed in it; and it becomes smooth on the surface, being invested by a dense cellulo-fibrous periosteum, until, by the end of six or eight months, ossification is perfect. The last process in the consolidation of the fracture is the formation of new bone between the broken ends. This does not take place definitely until a considerable period after the ensheathing callus has been formed. Billroth of Vienna, who has investigated this process, finds that cells are developed in the Haversian canals; and that these become dilated by the gradual absorption of their bony walls, while the cells increase in number, and the blood-vessels form loops. Thus there is a removal of old tissue, and a deposit of new plastic matter; and these processes go on at both the fractured ends, so that the new deposits meet and unite, and ultimately become converted into bone. In some instances, however, the plastic matter, instead of being ossified, undergoes transformation into a fibrous tissue, as in the ordinary cicatrices of soft parts, giving rise to false joints, of which we shall speak hereafter. By the time that the intermediate or definitive callus is fully formed, that portion of the ensheathing or provisional callus which is not required for the preservation of the permanent integrity of the bone, has been gradually removed, or has moulded itself closely to the shape and condition in which it will ultimately remain, the medullary canal having again become free, and the ends of the fracture rounded off. In some cases the medullary cavity is not restored to its former condition for a considerable time, continuing to be partially occluded by a thin septum of callus.

Fig. 139.—Section of Fractured Tibia, four weeks after accident.

According to Paget, the plastic matter that is effused around and be-

tween the bones undergoes ossification in various ways. Those fractures that unite quickly do so most commonly through ossification of fibrous tissue in a rudimental condition, which may be either that of nucleated cells or nucleated blastema. A fine closely granular ossific deposit takes place in the blastema, and gradually forms the laminæ of a delicate cancellous tissue, the nuclei becoming probably converted into bone-corpuscles. In other cases again the union may be accomplished by the ossification of perfect fibrous tissue, developed from the plastic matter thrown out round the fracture. Then again, the new bone may be formed by the plastic exudation passing through a cartilaginous stage. Pure fœtal cartilage has so far only been seen in the lower animals; in man, the cartilage has always been of the fibrous variety.

In those fractures that are transverse, and that remain in steady apposition during ossification, and more especially if they be but thinly covered by soft parts, the union appears to take place directly and immediately between the opposed osseous surfaces; there being no appearance of those accessory deposits of bone that usually go by the name of "provisional callus." If, however, the fracture occur in a bone that is thickly invested by soft parts, masses of new bone will be thrown out around the fragments, evidently the result of deposition from the surrounding inflamed tissues rather than from the injured periosteum or bone. The influence of the neighboring soft parts in determining the deposits of new bone is well marked in the tibia. In a fracture of this bone we find that at the anterior and inner part, which is thinly covered, union takes place directly between the broken ends; but at the posterior and outer side, where there is a thick envelopment of tissue, a large mass of provisional callus will often be found, filling up even the interosseous space. That neighboring parts participate in the inflammation set up around the fracture, and throw out callus, is evident from what takes place occasionally when one of the bones of the fore-arm or leg is broken. Periostitis is then set up in the unbroken bone, opposite the seat of fracture, and osseous matter is sometimes deposited by it. We have specimens illustrating this point in the University College Museum.

In fractures occurring in young infants, the quantity of callus thrown out is proportionately very great. This may perhaps be owing to the difficulty of maintaining such fractures in steady apposition, and partly also to the activity of the nutritive process.

If the fracture be not well reduced, the ends not being in proper apposition, or if it be comminuted, masses of new bone are often deposited as buttresses or supports, or, enveloping the splinters, consolidate them with the rest of the shaft. So, also, when the fractured bones are not kept sufficiently quiet during treatment, the neighboring parts become irritated, and provisional callus is formed. Hence, as Paget has remarked, we commonly find this deposit in fractures of the ribs, which are kept in constant motion by the respiratory actions. In impacted fractures there is, from the perfect apposition of the surfaces, but little callus formed.

From all this, I think it clear that in simple fractures the *provisional* callus is deposited principally by the surrounding soft tissues, and also, to a certain extent, by the periosteum and medullary canal, its quantity being dependent on the amount of irritation set up in these structures. The *definitive* callus, on the other hand, is directly and immediately formed by the vessels of the fractured bone itself, and the comparative want of vascular supply to this tissue may account for the slowness of its formation.

Union of Compound Fractures.—The difference between the union of a simple and of a compound fracture is the same as that between the healing of a subcutaneous and an open wound. In the one case, the healing process takes place without any sensible local disturbance or constitutional derangement; in the other, it is accompanied by local inflammation and suppuration, and by corresponding febrile reaction. In the one case, there is no exciting cause for the development of secondary diseases; in the other, the local mischief is extremely apt to generate these in their worst form, as erysipelas, inflammation of the absorbents or veins, and pyæmia. In compound fractures, union takes place by the ends of the bone, which lie bathed in the pus of the wound, granulating and throwing out plastic matter, which becomes directly converted into bone. There is in many cases but little provisional callus; but in most instances a large quantity of accessory osseous deposit takes place, more particularly if the displacement be great. The union of these fractures precisely resembles that of a wound in the soft structures—by granulation, or "the second intention;" the only difference being that the granulations which are thrown out by the bone and periosteum develop into new osseous tissue either directly, or through the medium of an antecedent fibroid transformation. This process necessarily occupies a much longer time than that which is required for the union of a simple fracture, consolidation not being effected for three or four months, and often being very considerably retarded beyond this by the separation of necrosed bone, the formation of abscesses, &c. Rokitansky and some other pathologists are of opinion that superficial exfoliation of that layer of bone which is bathed by the pus takes place, and that it is after this is separated that the granulations spring up, in which the new bone is deposited: but I think that it admits of very considerable doubt whether this process of necrosis goes on in all cases of compound fracture.

Union of fractures, like all other vital actions, takes place more readily and much more quickly in the early periods of life than at a more advanced age, and is always more speedily accomplished in the upper than in the lower extremities.

TREATMENT OF FRACTURE.

Constitutional Treatment in simple fractures requires but a very few words of explanation. As a rule, the general habits of life should be interfered with as little as possible. In uncomplicated fractures of the upper extremities, more especially in the young, rest for a few days in bed is all that is needed. The patient may then be allowed to move about moderately with the limb supported on proper apparatus. In the fractures of the lower extremities more lengthened rest is needed. In these cases the diet may be somewhat reduced, and aperients given with advantage for the first week or ten days. After this the usual habits of life in these respects should be resumed.

In old persons the enforced confinement to bed and the sudden interruption of the ordinary habits of life, as well as the shock to the system, are apt to exercise an injurious and sometimes a fatal effect. In these cases there are two dangers to apprehend, viz., sloughing of the back and hypostatic congestion of the lungs. Both are avoided by propping the patient up in bed, the use of water or air cushions, and change of posture as far as practicable. It is necessary to see that the bed is very smooth and firm—without creases; that all crumbs be swept away daily; and that scrupulous attention be paid to cleanliness after the use of the

bed-pan. Good diet and a fair allowance of stimulants are needed in these cases. The early use of the starched or plaster of Paris bandage is of great service in enabling the patient to get up sooner than could otherwise be done.

In all cases of simple fracture of the lower extremities, the sooner the patient is got up and about on crutches the better. Some patients speedily learn to use these instruments, others never get accustomed to their use. In the latter case, a wheel-chair should be substituted for them.

SURGICAL TREATMENT OF SIMPLE FRACTURE.—In conducting the treatment of a fracture, the object of the Surgeon should be not only to obtain a sound and strong limb, but one that presents as little deformity and trace of former injury as possible. In order to accomplish this, the broken ends of the bone must be brought into as perfect apposition as possible, the recurrence of displacement must be prevented, and the local and constitutional condition of the patient properly attended to.

When the Surgeon is called to a person who has met with a fracture, if it be a severe one of the upper extremity, or of any kind of the lower limbs, he must see that the bed, on which the patient may have to remain for some weeks, is properly prepared, by being made hard, flat, and firm, and, if possible, covered with a horse-hair mattress. The Surgeon must then superintend the removal of the patient's clothes, having them ripped along the seams, so that they may be taken off with as little disturbance as possible to the injured part. He next proceeds to the examination of the broken limb, using every possible gentleness consistent with acquiring a proper knowledge of the fracture. After he has satisfied himself upon this point, the limb should be laid on a soft pillow, until any necessary apparatus has been prepared.

Reduction.—When all has been got ready, the reduction of the fracture, or the bringing the fragments into proper apposition, must be proceeded with. This should, if possible, always be done *at once*, not only lest any displacement that exists may continue permanently—the muscles, after a few days, becoming shortened, rigid, and unyielding, not allowing reduction to be effected without the employment of much force—but also with the view of preventing irritation and mischief to the limb, by the projection of the sharp and jagged ends of bone into the soft structures. A great deal of time is sometimes lost, and much unnecessary pain inflicted upon the patient, and great irritation set up in the limb, by the Surgeon leaving the fracture unreduced on a pillow for several days, and applying evaporating lotions to take down the swelling and avert the threatened inflammation, which are consequences of the non-reduction of the broken bone. The application of cold lotions, irrigation, &c., in compound or even in simple fractures is decidedly injurious. It lowers the vitality of the part, retards union, and occasions œdema. By early reduction we may sometimes prevent a sharp fragment from perforating the skin, and thus rendering a simple fracture compound, or lacerating muscles and nerves, inducing perhaps traumatic delirium and certainly undue local inflammatory and spasmodic action.

The chief cause of displacement in fractures has already been stated to be muscular contraction; hence, in effecting reduction of a fracture and in removing the displacement, our principal difficulty is the action of the muscles of the part. This must and always may be counteracted, by properly relaxing them by position; so soon as this is done, the bony fragments will naturally fall into place; but no amount of extension and of counter-extension can bring these into position, and much less retain them there, unless all muscular influence be removed. In ordinary frac-

tures, no force is necessary or should ever be employed for accomplishing this; but attention to the attachment of the muscles of the limb and proper relaxation of them is all that is required. In impacted fractures it is occasionally necessary to use force in order to disentangle the fragments, but this is the only form of fracture in which its employment is justifiable. In effecting the reduction, not only must the length of the limb be restored, but its natural curves must not be obliterated by making it too straight.

Prevention of Return of Displacement.—After the reduction has been accomplished, means must be taken to prevent the return of the displacement; for, if the parts be left to themselves, muscular action, or the involuntary movement of the patient, will be certain to bring about a return of the faulty position. In many cases, it is exceedingly difficult, for the first few days, to keep the ends of the bone in place, in consequence of spasmodic movement of the muscles of the limb, or of restlessness on the part of the patient. About this, however, the Surgeon need not be anxious, as no union takes place for the first week or ten days; at the expiration of that time the muscles will have probably lost their irritability, and the patient have become accustomed to his position, so that with a little patience, or by varying the apparatus and the position of the limb, good apposition may be maintained.

The return of displacement is prevented, and the proper shape and length of the limb are maintained, by means of *bandages*, *splints*, and *special apparatus* of various kinds. In applying these, care should be taken not to exert any undue pressure on or forcible extension of the limb. Pads and compresses of all kinds should, if possible, be avoided; they do no good that cannot be effected by proper position, and even occasion serious mischief by inducing sloughing of the integuments, over which they are applied. A screw-apparatus has been invented with the view of forcing fragments into proper position, but nothing can be more unsurgical and unscientific than such barbarous contrivances.

In cases in which there is much tendency to a return of the displacement, it has been recommended to divide the tendons of some of the stronger muscles inserted into the lower fragment. This, however, can very rarely be necessary; and in those cases in which I have done it, or seen it done, no material benefit has resulted.

The **Bandages** used for fractures should be the ordinary grey calico rollers, about three finger-breadths in width, and eight yards in length. In applying them, especial care must be taken that the turns press evenly upon every part, and that the bandage be not applied too tightly in the first instance. No bandage should be applied *under* the splints, more particularly at the flexures of joints, and care must be taken that the limb be not bent, or its position otherwise materially altered, after bandages have been applied. A bandage *under* the splints is not only useless, but highly dangerous, by inducing risk of strangulation. No bandage should be applied to the part of the limb that is the seat of fracture. The part below the fracture may be sometimes advantageously bandaged, in order to prevent œdema; thus, in fracture of the humerus, the fingers and fore-arm may be bandaged with this view, but no turns of the roller should be brought above the elbow. This point of practice I consider most important, as the application of a bandage to the immediate seat of fracture not only causes great pain and disturbance of the limb, but danger of gangrene. When once a fractured limb has been "put up," the less it is disturbed the better. No good can possibly come, but a great deal of pain must necessarily result to the patient, from meddling

with it. The Surgeon should always bear in mind that, in the treatment of a fractured bone, he can do absolutely nothing to promote its union, beyond placing it in a good and easy position. Nature—the natural reparative action of the body—solders the bone together; and the less the Surgeon interferes with the natural processes of repair, the more satisfactorily will union be accomplished. But it is requisite to examine the limb from time to time during the treatment, and especially about the second or third week, when union is commencing, in order, if necessary, to correct displacement. In the earlier stages, supervision is necessary lest the bandage be too tight; and, if the patient complain of any pain or numbness, or if the extreme part look blue and feel cold, the bandage must be immediately removed; for, though the apparatus have not been applied tightly, swelling of the limb may come on from various causes, to such an extent as to produce strangulation and consequent gangrene of it, as I have seen happen in at least three instances, the limb requiring amputation in each case (Fig. 145). It is remarkable, that the whole of a limb will fall into a state of gangrene in these circumstances, with but little pain, and often with very slight constitutional disturbance, the parts having their sensibility deadened by the gradual congestion and infiltration of the tissues. When such an unfortunate accident happens, recourse must be had to immediate amputation. Before applying the apparatus in a case of fracture, and as often as it is taken off, it is a good plan to sponge the limb with warm soap and water, which prevents the itching that otherwise occurs and is sometimes very troublesome.

The **Splints** that are used in cases of fracture are of various kinds. Tin, wood, leather, and gutta-percha, are the materials usually employed. For some kinds of fracture, special, and often very complicated apparatus, is very generally used; but the Surgeon should never confine himself to one material, or one exclusive mode of treating these injuries, as in different cases special advantages may be obtained from different kinds of splints. Wood and tin are principally employed in the lower extremity, where great strength is required to counteract the weight of the limb and the action of its muscles; and care must be taken to pad very thoroughly splints made of these materials. Leather, gutta-percha, and pasteboard, are more commonly useful in fractures of the upper extremity, though they may not unfrequently be employed with advantage in those of the lower limbs. In applying them, a pattern should first be cut out in brown paper, of the proper size and shape: the material must then be softened by being well soaked in hot water, and moulded on to the part whilst soft: as soon as it has taken the proper shape, it should, if leather or gutta-percha be used, be hardened by being plunged into cold vinegar and water; the pasteboard must be allowed to dry of itself. Its edges may then be feathered and the corners rounded, and its interior lined with wash-leather or lint. These splints have the advantage of great durability, cleanliness, and lightness. The material of which the splint is composed is of less consequence than its mode of application. There are two points that require special attention in this respect:—1, that when the splint is flat it should be sufficiently broad to extend to the exterior of the limb, and not to press into it; and 2, that it should embrace securely and fix steadily the two joints connected with the fractured bone; if the thigh, the hip and knee; if the leg, the knee and ankle. From want of attention to these points of practice much trouble is often occasioned in keeping the fragments in steady apposition, and much deformity often results. It is impossible to keep

the fragments perfectly immobile, and in close and accurate apposition, unless these very important points be attended to.

Special Apparatus should be employed as little as possible in the treatment of fractures. It is scarcely ever necessary in simple fracture, and is far more cumbersome and costly than the means above indicated, which are all that can be required. I have no hesitation in saying, that a Surgeon of ordinary ingenuity and mechanical skill may be fully prepared to treat successfully every fracture to which he can be called, by having at hand a smooth deal plank half an inch in thickness, and a sheet of gutta-percha, undressed sole-leather, or pasteboard, to cut into splints as required.

To the simple means above described the **Starched Bandage** is an invaluable addition. Although various plans for stiffening and fixing the bandages in cases of fracture, by smearing them with white of eggs, with gum, plaster of Paris, &c., have been employed at various times, it is only of late years that the full value of the starched bandage has been recognised by Surgeons, chiefly through the practice and writings of Baron Seutin.

The advantages of the starched bandage in the treatment of fractures, as well as in many other injuries and diseases, consist in its taking the shape of the limb accurately and readily, and maintaining it by its solidity; in its being light, inexpensive, and easily applied, with materials that are always at hand. It secures complete immobility of the limb in the position in which it dries. The joints in the neighborhood of the fractured bone are securely fixed, and the perfect adaptation or moulding of the apparatus to the inequalities of the limb prevents all movement. Thus it becomes a powerful and efficient extending apparatus, maintaining accurately not only the length but the normal curves of the limb. From its lightness, it possesses the very great and peculiar advantage, in fractures of the lower extremity, of allowing the patient to remain up and to move about upon crutches during nearly the whole of the treatment; thus, by rendering prolonged confinement to bed unnecessary, it prevents the tendency to those injurious consequences that often result from these injuries; and, by enabling the patient to keep up his health and strength by open-air exercise, it facilitates the consolidation of the fracture. In addition to this, the patient will often be able to carry on his business during treatment. By employing the starched bandage in the way that will be immediately pointed out, I scarcely ever find it necessary to keep patients in bed with simple fractures of the leg for more than six or seven days, thus saving much of the tediousness and danger of the treatment.

The following is the mode of applying this apparatus that is adopted at the University College Hospital, and which will be found to answer well. The whole limb is enveloped, as recommended by Burggraeve, of Ghent, in a layer of cotton-wadding, which is thickly laid along and over the osseous prominences; this, being elastic, accommodates itself to the subsequent diminution in size of the limb, and keeps up more equable pressure. Over the cotton-wadding are laid splints of thick and coarse pasteboard soaked in thin starch, properly shaped to fit the limb. The pasteboard should be soft, not milled, and be doubled and torn down, *not* cut, as in this way the edges are not left sharp. If much strength be not required, as in children, or in some fractures of the upper extremity, a few slips of brown paper, well starched, may be substituted for the pasteboard. A bandage saturated with thick starch is now firmly applied; and lastly, this is covered by another dry roller,

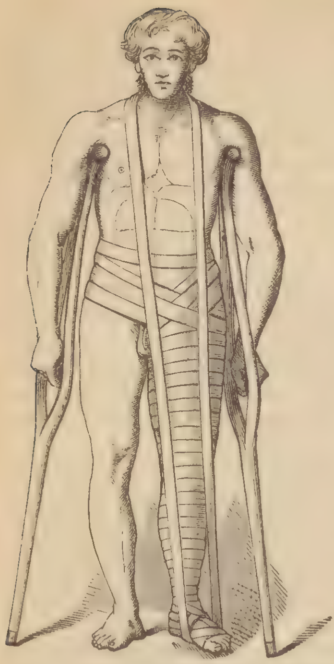


Fig. 140.—Starched Bandage applied to Fractured Thigh.

the inner sides of the turns of which may be starched as it is laid on. No roller or bandage should be applied directly to the fractured part under the splints: its application is always painful and difficult, and it is attended with danger of constriction or abrasion. Both the pasteboard splints and the starched bandage should always include the two joints above and below the fracture, so that complete immobility of the fragments may be secured: the hip and knee when the thigh is broken; the knee and ankle when the leg is fractured. During the application of this apparatus, extension must be kept up by an assistant, so as to hold the fracture in position; and, until the starch is thoroughly dried, which usually takes from thirty to fifty hours, a wooden splint may be applied to the limb, so as to keep it to its proper length and shape. The drying of the starch may, if necessary, be hastened by the application of hot sand-bags to the apparatus. After the bandages have become quite dry, the temporary splint must be removed, and the patient may then be allowed to move about on crutches, taking care, of course, to keep the injured limb well slung up, and not to bear upon it, or to jar it against the ground (Fig. 140). In the course of about three

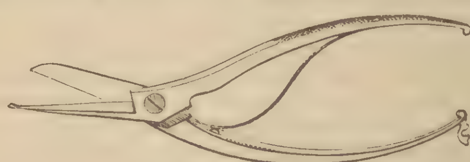


Fig. 141.—Seutin's Pliers.

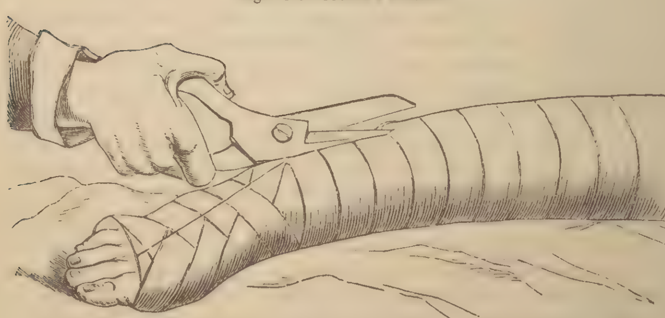


Fig. 142.—Application of Seutin's Pliers to Starched Bandage.

or four days after its application, the apparatus will usually be found to have loosened somewhat, the limb appearing to shrink within it. In

these circumstances it becomes necessary to cut it up with a pair of Seutin's pliers, such as are represented in Fig. 141. This section must be made, as represented in Fig. 142, along the more muscular part of the limb, so that the skin covering the bones be not injured; and, after paring the edges of the splint, it must be reapplied by means of tapes or a roller. In trimming the edges of the splint, it should not be removed from the limb. If the fracture be compound, a trap may be cut in the apparatus opposite the seat of injury, through which the wound may be dressed (Fig. 143).

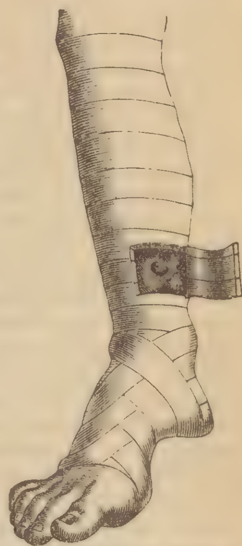


Fig. 143.—Starched Bandage: Trap left for Dressing Wound.

Although fully recognising the great advantages to be obtained by treating fractures on this plan, and employing the starched bandage in almost every case that came under my care, I did not at first think that it was safe practice to have recourse to it during the early stages of fracture; until, indeed, the swelling of the limb had begun to subside. I therefore never applied it until the sixth, or eighth, or tenth day, keeping the limb, until this time, properly reduced upon a splint, very lightly bandaged, and wet with cold evaporating lotions; fearing that if the bandage were applied at too early a period, the inflammatory turgescence of the limb might give rise to a slow strangulation of it under the apparatus.

During many years, however, I employed Seutin's plan in several hundreds of fractures of all kinds, putting up the limb in the starched apparatus *immediately* after the reduction of the fracture. I have found the practice an extremely successful one, even in fractures of the thigh; so much so, that at the Hospital I now rarely use any other plan of treatment than the "movable-immovable" apparatus in some form varying with the fashion of the day; and, indeed, the more experience I have of it, the more satisfied am I with the results obtained by it. The moderate pressure of the bandages, aided probably by the great evaporation which goes on during the drying of so extensive and thick a mass of wet starch, and which produces a distinct sensation of cold in the limb, takes down the extravasation most effectually, and enables the patient usually to leave his bed about the third day after the injury, when the fracture is in the leg or ankle, and about the sixth when it is the thigh that is broken; so that we now treat all patients with simple fractures of the leg, and many children with fractures of the thigh, as outpatients.

From no other means of treatment have I seen such satisfactory results in cases of fractured thigh, as from the starched apparatus; patients having frequently been cured without any appreciable shortening, with the preservation of the natural curve of the bone, and without confinement to bed after the first week.

In compound fractures also of the leg, and even of the thigh, I have obtained most satisfactory results from this means. In compound fractures of the leg, I have seen the patient walking about on crutches as early as the tenth or fourteenth day, the limb being securely put up in starch; and have more frequently succeeded in getting union of the

wound, and consequently in converting the compound into a simple fracture, by putting up the limb in this apparatus than in any other.

Glue may be substituted for starch in stiffening the fracture apparatus. The glue used for this purpose should be prepared by making a strong solution of the best French glue, and then adding to this about one-eighth of spirits of wine. This mixture may then be thickly brushed over the bandage. After drying, the apparatus should be cut up, trimmed, and fixed on by straps, lacings, or bandages, as most convenient. It possesses the advantages over the starched bandage of drying more quickly, and of being lighter and more elastic, but it is not so strong or so well adapted for purposes of support when the whole of a muscular limb or large joints have to be included.

The **Plaster of Paris Bandage** may often be advantageously used as a substitute for the starched apparatus. It may be applied in one of the three following ways.

1. A bandage of coarse soft muslin has dry plaster of Paris thoroughly rubbed into its meshes; it is then rolled up, and some cold water is poured upon each end of it so as to moisten it through. A dry flannel roller having been previously applied to the limb, the wetted plaster bandage is smoothly rolled over it, the Surgeon taking care that no reverses are made. In order to avoid these, it may be applied in a spiral or figure-of-8 manner over the more unequal parts. Slips of the plaster bandage should also be laid on where additional strength is required, and the whole well wetted from time to time during the application. It hardens in the course of a few minutes, and, as it dries, forms a solid, hard, and light casing to the limb, affording excellent support to the fracture. The plaster bandage possesses the advantage over the starched apparatus of being lighter, and especially of drying and hardening very quickly—qualities which render it invaluable in cases in which it is necessary to carry patients any distance immediately after setting of the fracture.

2. Neudörfer is a strong advocate for the employment of the plaster of Paris bandage. He recommends that it should be applied immediately (on this he lays great stress), in the following way. Compresses of linen, or of lint, are dipped in plaster of Paris of the consistence of a common poultice. These are then placed longitudinally on the limb, first on the upper, then on the under part. A few turns of a bandage keep them *in situ* till the plaster is set. To prevent the contiguous edges from adhering, they are slightly greased, or a slip of greased lint is put between them.

He sometimes uses pieces of thin wood, like veneer, lined with cotton-wool, next the skin; over these the bandage, saturated with the plaster, is applied by circular turns in the usual way. In applying the plaster bandage, no cotton-wool or other soft material need otherwise be laid between it and the skin. The bandage, soaked in plaster of the consistence of cream, is first applied in a circular manner, in the neighborhood of the fracture, which has previously been reduced. If this be compound, the wound must not be covered by the turns of the bandage. Three superimposed layers are usually sufficient to give stability. The same method is then applied to the bone above and below the fracture. The bandage, if properly applied, should be quite firm in eight minutes. The opening of the wound is then to be covered with cotton-wool of sufficient thickness to be on a level with the bandage; and over this must be fastened a handkerchief or ordinary bandage. As soon as the whole limb has been thus covered in, a dry strip of simple bandage is placed

along its whole length, and a piece of wire along each side of this; and the whole is then smeared and smoothed down with plaster of Paris. While the mixture is still moist, and before it is quite set, the ends of the wires are drawn up, and the casing is thus cut through by two narrow furrows along its whole length, by which it is in no way weakened. When it is necessary to remove the apparatus, the ends of the dry slip of bandage which lies between the furrows, are drawn up together, and a lid of plaster of Paris is removed. The subjacent plastered bandage is then easily cut through by scissors. In the case of a large limb, this proceeding may be adopted in several places, so that the apparatus may be cut into as many pieces as is necessary.

The setting of the plaster may be retarded by the addition to it of solution of borax. Thus a solution of 1 part to 12 of the water used will retard the setting fifteen minutes; and 1 to 8 will retard it fifty minutes, and so on.

3. The method of applying the plaster apparatus, as practised in the Bavarian army during the Franco-German War, is as follows. Two pieces of flannel, twenty inches broad, are stitched together down the middle for the length of the leg; and beyond this both are cut through in the same line for the length of the foot. The flannel is placed under the limb, so that the seam reaches from the ham to the heel. The sides of the inner piece are brought together over the leg, and fixed in front, and along the sole, by hare-lip pins (bent at a right angle, so that they may be easily extracted afterwards), and thus a closely fitting stocking is formed. The sides of the outer piece are then brought forwards and cut, so that each may overlap the middle line of the leg and sole by three quarters of an inch. The limb is then laid on one side: and while the outer piece of flannel is held back, a layer of plaster of Paris of the consistence of thick cream is spread evenly, to the thickness of half an inch, over the inner piece, and made to pass quite to the seam behind, and the line of junction of the sides of the inner piece in front. The outer piece is pressed over this before it sets, and should just reach the middle line in front and along the sole. When this has set, the limb is turned over, and the process is repeated on the other side. The pins may now be removed. The seam serves as a hinge; and when the whole has set, the splint may be taken off, the edges of the plaster trimmed, and those of the inner piece of flannel cut so as to leave sufficient to turn over and stitch down on the outer piece. The splint is then re-adjusted and fixed by a bandage (Fig. 144.)

Fig. 144.—Bavarian Plaster Splint: adjustment of the Flannel Layers.

In all cases in which the plaster bandage is used, there is danger of unsafe constriction of the limb after the setting of the plaster, either in consequence of the apparatus having been applied too tightly, or of the inner bandage, which has been directly applied to the limb, becoming

tightened by the swelling of the member within it. Hence great care must be taken for several days after the application of the apparatus, to watch the limb carefully, and if signs of over constrictions come on, such as pain, coldness, numbness, and œdema of the extremities, whether toes or fingers, immediately to cut it up, re-adjust, or remove it. No time should be lost in doing this, as the limb may have become gangrenous in patches, with little suffering to the patient or constitutional disturbance.

In the treatment of ordinary simple fractures of the shafts of long bones, the following are the chief points that require attention:

1. To effect reduction at once, and with as little disturbance of the limb as possible.

2. Not to apply any roller to the part of the limb in which the fracture is situated, nor under the apparatus.

3. To line, pad, or wad the apparatus thickly.

4. To include and fix in the apparatus the two joints connected with the injured bone.

5. To disturb the apparatus as seldom as possible.

6. To use starched pasteboard or plaster apparatus, when practicable, in preference to any more special form of appliance.

Accidents during Treatment.—Various accidents are liable to occur during the treatment of a fracture; some of these are general, others special. Amongst the more general accidents, Tetanus, Traumatic Delirium, and Erysipelas may be mentioned as the most common. Amongst the more special, the occurrence of Spasm of the Muscles of the Limb, Abscess, Œdema, Gangrene, and a tendency to Pulmonary and Cerebral Congestion, are those that have most to be guarded against.

In order to prevent the occurrence of these conditions, the general health must be carefully attended to; the bowels being kept open, the room well ventilated, nourishing diet allowed, and long confinement to bed avoided by the use of a "movable-immovable" apparatus, as above described.

The treatment of the more general accidents presents nothing that need detain us here; but those that are more special and peculiar to fractures require consideration.

Crutch-palsy of the hands and arms may occur as the result of compression of the brachial nerves against the pad of the crutch. The whole plexus, or only one of its component nerves, as the musculo-spiral, or ulnar, may be affected. The remedy is obvious—it consists in the discontinuance of the use of the crutch, and, if need be, the employment of electricity to the palsied muscles.

Spasm of the Muscles of the Limb, owing to the irritation produced by the fragments, is often very severe so long as the fracture is left unreduced; the sharp end of the broken bone puncturing and irritating the surrounding muscles. It is best remedied by reduction, and the maintenance of the fracture in proper position by moderate pressure with a bandage. In troublesome cases, compression of the main artery of the limb has been recommended by Broca. If the spasm be dependent upon nervous causes, full doses of opium will not unfrequently afford relief. In some cases it is of a permanent character, producing considerable displacement of the fragments. In these circumstances, division of the tendons has been recommended; but this practice appears to be an unnecessarily severe one, and may certainly most commonly be avoided by attention to the other plans of treatment which have been suggested.

Œdema of a broken limb may occur from several causes, viz., overtight bandaging, dependent position, pressure of blood, extravasation

or inflammatory effusion. It is of no great moment in itself, but may be of consequence, as indicative of a liability to gangrene if left unrelieved. The proper relief may usually be afforded by loosening the bandages, and elevating the limb.

The œdema which is often very persistent after the cure of the fracture, is best relieved by diligent friction, bandaging, and attention to position.

Considerable Extravasation of Blood is frequently met with in cases of simple fracture, causing great swelling and tension. By the continuous application of cold evaporating lotions, the collection is usually readily absorbed; and the Surgeon should never be tempted by any feeling of fluid or of fluctuation to open it, as he would thereby infallibly convert the simple into a compound fracture, and give rise to extensive ill-conditioned suppuration. In some of the cases of extensive extravasation, the limb appears to relieve itself of the serous portion of the blood effused, by the formation of large bullæ or blebs, which may be punctured, or else allowed to burst and subside, without any material inconvenience. This extravasation very rarely indeed, runs into abscess; if it do it must of course be opened, and treated upon ordinary principles. If deeply effused it may lead to gangrene, by the constriction and compression which it exercises on the vessels of the limb.

Gangrene as a complication of simple fracture is a most serious mischance, and one from which it is difficult for the Surgeon to exonerate himself without blame. But he is not always in fault. It may arise from causes residing in the limb. It may be contributed by the negligence of the patient in not drawing the Surgeon's attention to early symptoms, after having been duly warned. Gangrene of the limb (Fig. 145) may occur after simple fracture as the result (1) of tight bandaging; (2) of the swelling of the limb and compression of the vessels consequent upon extravasation of blood, or (3) of inflammatory infiltration causing strangulation within a bandage that has been at first but lightly applied. Gangrene is almost invariably the consequence of the pernicious and dangerous practice of applying a bandage *directly* to the limb under the apparatus. I have never known gangrene to occur after fracture, except where this has been done, since it is much more likely to occur in those cases in which the fracture is treated by the unskilful application of an immovable apparatus, whether of starch, plaster of Paris, or other similar material, than when splints are used. Indeed, if the splints be well wadded, and no bandage be put on under them, it is almost impossible that an undue or dangerous amount of constriction can be exercised on the limb, so as to interrupt the circulation through it. I believe that this accident would rarely, if ever, occur, if the Sur-

Fig. 145.—Gangrene of Fore-arm and Hand from Tight Bandaging.

geon were to avoid the direct application of a bandage to the limb, however lightly, in fractures, more particularly in children. The danger of strangulation is especially great if, as happened in the case from which the accompanying cut is taken, the limb be bandaged whilst straight, and then flexed, as the bandage will then cut in deeply at the flexure of the joint, and certainly destroy the vitality of the part, if not of the whole limb. The pressure of an axillary pad, used in many of the fractures of the upper extremities, may also tend to the supervention of gangrene by interfering with the return of blood through the axillary vein, and thus causing slow strangulation under the bandage. Hence in these cases the fingers should be left free at their tips, and examined daily. Even if no *direct* bandage have been applied, the apparatus should at once be removed, and the limb examined, whenever the patient complains, even of slight uneasiness: or, indeed, if any appearances of congestion, such as blueness, coldness, œdema, or vesication of the fingers and toes, show themselves. If it be left on beyond this, gangrene will probably set in, slow strangulation going on under the bandages without much, if any, pain. Vesications often create much alarm, but too much importance must not be attached to their mere appearance. They will often occur of very large size, as has already been stated, as a consequence of the raising of the cuticle by the transuded serum of extravasated blood. It is only when associated with coldness of the limb, a dusky hue, and a putrescent odor, that they are indicative of gangrene. An excellent plan of judging of the activity of the circulation in a fractured limb after it has been put up, is to leave the ends of the fingers or toes uncovered by the bandage; when, by pressing upon one of the nails, the freedom of the circulation may be ascertained by noticing the rapidity with which the blood returns under it. A question of much medico-legal importance occasionally arises in connection with gangrene of the limb after simple fracture. It is this—is the gangrene owing to over-tight and consequent negligent bandaging by the Surgeon, or to passive strangulation by inflammatory swelling of the limb under bandages not originally too tightly applied? The diagnosis of the two conditions on which the answer is dependent is as follows: 1. When a bandage has been originally too tightly applied, the patient will suffer severely for several hours, the pain being felt immediately after the application of the apparatus. On loosening the bandage, the pain ceases. When removed, if gangrene have set in, the skin will be found pale where the roller has been applied—the limb being compressed and small at this part—marked with imprints at the edges of the turns of the bandage, whilst it is greatly swollen and congested at the fingers or toes beyond the bandage; these parts being also cold, purple, and vesicated. 2. When the strangulation occurs from spontaneous inflammatory swelling of the limb, the whole member is equally swollen; it is red and blue, hot in parts, cold and sphacelated in others. It does never become uniformly gangrenous, but deep infiltrating abscess, and localised sphacelus, form.

Treatment.—When a bandage or apparatus appears to be exerting undue, painful, or dangerous pressure, it must at once be removed. Should the circulation of the limb have been interfered with, friction with camphorated oil in an upward direction should be employed.

If gangrene have unhappily already occurred, the treatment will depend on the cause, and the conditions of the limb. If the gangrene be the result of self-strangulation of the limb, by its swelling up under the bandage, and it be found to be red, swollen, and infiltrated, free incisions

should be made, and the limb enveloped in hot fomentations. If, notwithstanding this, abscesses form, with deep infiltration of the cellular tissue, and sloughing of the skin and muscles, the choice lies between amputation and the preservation of a limb that will be withered, contracted, and useless.

If the gangrene be the result of direct strangulation of an over-tight bandage, as in Fig. 145, there is no resource left but amputation above the seat of constriction.

In fractures of the lower extremity occurring in old people, there is a great tendency to **Pulmonary and Cerebral Congestion**, partly from determination of blood, and partly as a consequence of the long confinement required; these fractures commonly prove fatal in this way. The use of the starched bandage, by enabling the patient to move about, is the most effectual preventive of these accidents.

Complicated Fractures.—Fractures may be **complicated** with various important local conditions. Extravasation of blood into the limb, from a wound of some large vessel, may go on to so great an extent as to occasion strangulation of the tissues; if not checked by position and cold applications, it may give rise to gangrene, and demand amputation. In other cases, again, the soft parts in the vicinity of the fracture may be contused to such a degree that they rapidly run into slough, thus rendering it compound; or a wound may exist, not communicating with the broken bone, but requiring much modification of treatment, and special adaptation of apparatus.

One of the most serious complications of a simple fracture is undoubtedly the **Rupture of the Main Artery** of the limb opposite the seat of fracture, or a wound of it by one of the fragments of broken bone. This accident chiefly occurs in fractures of the lower part of the femur or upper part of the tibia; the popliteal in one case, and the posterior tibial in the other, being the vessel wounded. The symptoms consist in the rapid formation of an uniform elastic tense swelling of the limb, with obscure pulsation or thrill, opposite the seat of injury, and cessation of pulsation in the arteries at the ankle, with coldness and numbness of the foot and lower part of the leg. If the posterior tibial be the vessel injured, the circulation in the arteries of the foot may return after a day or two, and the coldness and numbness may lessen. If it be the popliteal that is injured, no such amelioration will take place, but the diffused aneurism in the ham will increase, the circulation will become more and more impeded, and gangrene will result.

What should be the **treatment** of such a case as this? The Surgeon has three alternatives.

1. The case may be treated as one of open arterial wound, the tumor laid open, and the injured vessel ligatured at the seat of wound. The objections to this treatment are, that a large cavity is opened, which must suppurate, and will probably slough; that the fracture is rendered a compound one of the worst kind; and that the securing the artery is, in any circumstances, extremely difficult, and indeed uncertain, entailing such an amount of disturbance of the soft parts as seriously to imperil the vitality of the limb.

2. The circulation through the femoral artery may be arrested by compression or ligature of the vessel. I am not aware that compression has ever been tried in a case of diffused traumatic aneurism; but there can be no reason why the effects of pressure upon the artery, by means of Carte's or some other proper compressor, should not be tried before proceeding to more severe measures. Should it not succeed, the artery

may be tied in Scarpa's triangle. An operation there has several times been successfully done in such cases, more especially when the hæmorrhage has been the result of laceration of the posterior tibial artery. But this operation should only be done in those cases in which, notwithstanding the existence of diffused traumatic aneurism in the ham, the pulsation has returned in the arteries of the foot, and the warmth and sensibility of the member have been in part at least restored. If these evidences of a return of circulation through the anterior tibial have not taken place, it will be worse than useless to ligature the femoral, as gangrene must inevitably ensue.

3. Amputation of the thigh may be performed. This severe measure need not be carried out at once. The Surgeon may wait a day or two and watch the progress of events. If he find that there is no sign of restoration of pulsation in the arteries of the foot, that the coldness and numbness of the limb continue to increase, and, in fact, that gangrene is impending, then the sooner he amputates the better for the patient's safety. If the artery have been tied, and gangrene result, the limb ought at once to be removed.

To sum up, I would advise, in a case of diffused traumatic aneurism arising from and complicating a simple fracture of the lower extremity: 1. Not to open the tumor and search for the artery at the seat of wound; 2. To compress or tie the femoral, if pulsation have returned or continue in the arteries of the foot; 3. Should pulsation not have returned within two or three days, should gangrene be imminent, or actually have set in, or should the artery have been ligatured, and mortification have ensued, to amputate high in the thigh without further delay. It will thus be seen that, in a diffused traumatic aneurism complicating a fracture of the bones of the lower extremity, the ordinary treatment of diffused traumatic aneurism must be departed from, for these reasons: 1. That owing to the great displacement of parts and laceration of soft structures consequent on the fracture, it would be almost impossible to find the injured vessel; and, 2. That, if it were found, the opening up of the limb would leave a large ragged wound communicating widely with the broken bones, and leading to the worst form of compound fracture, with an amount of disorganization in the limb that could scarcely be recovered from.

However extensively a bone may be **comminuted**, good union will take place provided the fracture be simple; that is, provided no wound exist in the limb by which air may gain admission to the fracture or to the soft parts implicated in it. I have seen the lower end of the femur crushed, as if by a sledge-hammer, into a multitude of fragments; and yet excellent union resulted, the fracture being simple, without even a breach of integument. In such a case as this, if there had been the smallest wound to admit air into the limb, suppurative action of the most extensive and destructive character would undoubtedly have set in, and the patient's limb at least, if not his life, would have been lost. It is impossible to overestimate the advantage of an injury of this kind being *subcutaneous*.

A serious complication of simple fractures consists in their **Implicating a Joint.** The fracture may extend into a neighboring articulation, and thus give rise to considerable inflammatory action; in strumous subjects this may lead to ultimate disorganisation of the articulation, requiring excision, which I have several times had occasion to perform in these cases. But in healthy individuals a large articular surface may be traversed by lines of fracture in several directions, without material

inconvenience resulting. This we see in impacted fractures of the condyles of the femur or of the lower end of the radius. In several instances of this kind in which I have examined the limb after death, no sign of disease of the part has been manifested beyond a moderate amount of injection of the ligaments; the fractured incrusting cartilage uniting by plastic matter, and the synovia being clear and free from inflammatory exudation. But, although union of fractures extending into articulations takes place readily enough, it cannot be expected that the patient will recover as mobile a joint as if the fracture had merely traversed the shaft. In fact, in the majority of these cases, the patient will be left with a joint that is weak, stiff, and painful: and, if in the lower extremity, the limb may be unable to support the weight of the body for some considerable time. Possibly also, in many of these instances, an impaired joint will be left through life, as the necessary and unavoidable result of the injury, though not unfrequently unjustly attributed to negligence and want of skill on the part of the Surgeon.

The occurrence of **Dislocation** at the same time as the fracture, and from the same violence that occasions this, often causes great difficulty to the Surgeon, as it becomes necessary to reduce the dislocated joint before the fracture is consolidated. In several instances of this description which have fallen under my care, I have succeeded in reducing the dislocation at once, by putting up the limb very tightly in wooden splints, so as to give a degree of solidity to it, and to permit the lever-like movement of the shaft of the bone to be employed; and then putting the patient under chloroform, I have replaced the bone without much difficulty. Should the Surgeon have omitted to reduce the dislocation in the first instance, he must wait until the fracture has become firmly united, and then, putting the limb in splints or in starch, he may try to effect reduction, which, however, will then be very difficult.

The fracture in a limb which is the seat of an **old Unreduced Dislocation** is necessarily of very rare occurrence, but occasions no serious difficulty in diagnosis or treatment. I once saw and treated successfully with Dr. Bryant a case of this kind in the person of an old gentleman who, falling on the ice, fractured the left humerus, which had been the seat of an unreduced dislocation forwards for more than fifty years.

The existence of **an Ankylosed Joint** in a fractured limb gives but little trouble, beyond the necessity of modifying the splints in such a way as to fit the shape of the limb. I have treated fractures of the thigh, leg, and arm in such circumstances with perfect success, by adapting the splints to the angle formed by the stiffened joint.

Fracture of a bone into the **Site of an Excised Joint** presents no peculiarity of importance. I have met with it in the humerus at the elbow, and have treated the case as one of ordinary fracture of the epiphysis.

Fracture of the bone in the **Stump of an Amputated Limb** is a rare accident. I have twice had such cases under my care; once in a man, and another time in a woman, each of whom fractured the femur low down in the limb which had been amputated below the knee. There was no displacement of the fractured bone in either case, showing the influence of the weight of the limb in addition to muscular contraction in occasioning displacement of the lower fragment. In each case the accident was the consequence of a fall, and union readily took place under the starched bandage.

In cases of simple fracture occurring in the neighborhood of, or implicating large joints, passive motion is very commonly recommended at

the end of from four to six weeks; I think. however, with Vincent, that this is often apt to do more harm than good, and is seldom required, the natural action of the muscles of the part being fully sufficient to restore the movements of the articulation, with the assistance of friction and douches.

Amputation is but very seldom required in simple fractures, and I have never had occasion to practise it. Yet, in cases of very extensive and severe comminuted simple fracture of the lower end of the femur, or of the upper part of the bones of the leg, with implication of the knee-joint and injury to the popliteal or tibial arteries, as indicated by the cessation of pulsation in the vessels of the foot, removal of the limb might be proper, in order to save the patient from gangrene or diffused traumatic aneurism. But it is only when the main artery has been injured by spicula of fractured bone, that such fractures will require amputation. I have had under my care a man, in whom the condyles of both femora and the left patella were crushed into numerous pieces by a fall from a great height on both knees, the limbs feeling like bags of loose fragments of bone at the seat of the injury; yet. as neither the skin was broken nor the vessels injured, though both knee-joints appeared to be disorganised, the limbs were preserved, and good union ensued.

Compound Fracture.—A compound fracture is that form of injury in which there is an open wound leading down to the broken bone, at the seat of fracture. This injury is not only far more tedious in its cure than simple fracture, but infinitely more dangerous. The tediousness depends upon the communication of the fracture with the external air, causing it to unite by a slow process of granulation, instead of by the more speedy adhesive action that occurs in the simple form of injury. The danger is likewise partly due to the same cause; the process of granulation and suppuration being often attended by profuse discharge of pus from abscesses, by long-continued exfoliation of bone, or by the supervention of secondary disease, such as hectic, phlebitis, pyæmia, or erysipelas, so as to lead to the eventual loss of limb or life. Besides these dangers, which may be looked upon as indirect, the violence that occasions a compound fracture often shatters the limb to such an extent, as to lead to the immediate supervention of traumatic gangrene, to the loss of life by hæmorrhage, or to the certain and speedy disorganisation of the limb, as the consequence of the reactionary inflammation.

Question of Amputation.—As, therefore, compound fracture is attended not only by great prospective dangers, but also by serious immediate risk, the first question that always presents itself in a case of this injury is, whether the limb should be removed, or an attempt be made to save it. It is of great importance to settle this point at once; for, if amputation be determined upon, it should be done with as little delay as possible, there being no period in the progress of the case so favorable for operation as the first four-and-twenty hours. Should an injudicious attempt have been made at saving the limb, the Surgeon must wait until suppurative action has been set up before he can remove it; and then he will very commonly find that the occurrence of some of the diffuse inflammatory affections of an erysipelatous character will render any operation impracticable; or the supervention of traumatic gangrene may compel him to amputate in the most unfavorable circumstances. At a late period in the progress of the case, amputation may be required, in order to rid the patient of a necrosed and suppurating limb that is exhausting him by hectic.

It is true that primary amputations are very commonly fatal, especially when practised near the trunk; yet this cannot with justice be urged as an argument against their performance, as recourse should never be had to *primary* amputation except in cases in which it is evident that the patient's life must in all probability be sacrificed by the unsuccessful attempt to save the limb. In determining the cases in which immediate amputation should be performed, no very definite rules can be laid down, and much must at last be left to the individual judgment and experience of the Surgeon. One will attempt to save a limb which another condemns. But, in coming to a conclusion upon this important question, he must bear in mind that, though it is imperative to do everything in his power to save a limb, yet the preservation of a patient's life is the main point, and that course is the proper one which offers the greatest prospect of effecting this. A wise conservatism is much to be applauded, but decision in determining the expediency of amputation is equally characteristic of a good Surgeon. In coming to a conclusion on a question of such vital moment as this, he must consider not only the nature and extent of the fracture, but the age, constitution, and habits of the patient; and though he may be guided by those general rules which have already been laid down at pp. 228 and 247, when treating of amputation in contused wounds and in gun-shot injuries, yet he will often show more wisdom and a greater amount of skill, in departing from the strict letter of surgical law, and in making a successful effort to save a limb, which, by adherence to surgical precepts, would be condemned; or in attempting to preserve the patient's life, by sacrificing a limb that is not injured to a degree that would usually be considered to justify amputation.

1. Those fractures must be looked upon as most unfavorable in which the wound is the consequence of the violence that breaks the bone, and in which there is **much Laceration of, and Extravasation into, the Soft Parts**; more particularly if the integuments be stripped off, portions of the muscular bellies protrude, and the planes of areolar tissue between the great muscles of the limb be torn up and infiltrated with blood. Injuries of this description occurring in the lower extremity always require amputation. The danger to the patient increases not only in proportion to the amount of comminution of the bones and of injury to the soft parts, but almost in the exact ratio of the proximity of the injury to the trunk. Thus, amputation of the thigh for bad compound fracture of the leg, though a very serious operation, is sufficiently successful; but when the femur itself is badly fractured and amputation of the thigh high up is required, recovery can indeed but seldom be expected. A bad compound fracture of the thigh, high up, may almost be looked upon as a fatal accident (*vide* pp. 127 and 247). In the arm, such accidents are not so serious, and the member may be saved, unless the bones be greatly comminuted.

2. The complication of a compound fracture with the **Wound of a Large Joint**, more especially if there be crushing or splintering of the bones which enter into its formation, with extensive laceration of the soft parts, is one of the most serious injuries that can be inflicted on a limb; and, when occurring in the lower extremity of the adult, is a case for amputation—unless it be the hip-joint that is damaged, when there will generally be so much injury of the pelvic bones and their contained viscera, as to preclude the performance of any operation. In children recovery may be effected in cases that would be helpless in the adult, and under antiseptics many limbs, in which the joints are opened by fracture

of contiguous bones, are saved that were formerly doomed to the knife. When the elbow or the shoulder-joint is the seat of compound comminuted fracture, with extensive injury of the soft parts, and possibly laceration of contiguous nerves or large bloodvessels, the case is one for immediate amputation. But, if the injury be limited to the bones, the soft parts being in a favorable state, resection of the articulation may advantageously be practised. This operation is usually a somewhat irregular proceeding, being conducted according to the extent of the wound, and consisting rather in picking out the shattered fragments of bones, and sawing off projecting and sharp-pointed fragments, than in methodical excision.

A peculiar accident is occasionally met with in young people, consisting in a **fracture** of one of the long bones **at the junction of the shaft and epiphysis**, and the protrusion of the end of the shaft through the muscles and integuments. In these cases, although the fracture is in close vicinity to the joint, the articulation is not affected, and careful examination will always prove its sound condition. Reduction in such cases is difficult, and it is usually impossible to maintain it without sawing off the projecting end of the shaft. This is easily done, and union takes place readily between the epiphysis and the remainder of the shaft. In two instances in which I have had to do this in lads, one near the shoulder, the other near the ankle, an excellent result without impairment of freedom of action in the joint followed the operation.

3. When one of the **larger Arteries of the Limb has been wounded** by the violence that occasions the fracture, or has been lacerated by the broken bone itself, there may be copious arterial hæmorrhage externally, as well as extravasation into the general areolar tissue of the limb. These cases most commonly require immediate amputation. Whilst the patient is being examined, and preparation made for the operation, dangerous effusion of blood must be carefully prevented by the elevated position and by the application of a tourniquet. For want of this simple precaution, I have seen very large and even fatal quantities of blood gradually lost, by being allowed slowly to trickle from the wound.

In these cases it has been proposed by some Surgeons of great eminence, to enlarge the wound in the limb, or to make an incision down to the fracture, and attempt to tie the artery where it has been injured. It is easy to give, but difficult to carry out, such precepts. In most cases they are scarcely practicable, as the Surgeon would have to grope in the midst of bleeding and infiltrated tissues, and would experience the greatest possible difficulty in finding the wounded vessel, after a search which would materially tend to increase the disorganisation of the limb. Even after the amputution of a limb in this condition, it is often by no means easy on dissection to find the artery that has poured out blood; and how much more difficult must it be to search for it successfully during life!

The ligature of an artery at a higher point of the limb does not hold out much prospect of success, for the same reasons that render its performance inadmissible of ordinary wounds of arteries (p. 297). This operation has succeeded in restraining hæmorrhage or in curing diffused traumatic aneurism in simple fractures. But I know of no case in which it has been successful in the permanent arrest of *primary* hæmorrhage in a compound fracture. If, then, proper means directed to the wound, such as position, pressure, or perhaps the attempt at ligature if the artery can be easily reached, be not successful, no course is left to the Surgeon but to amputate the limb without delay. This is more especially

the case if it be the lower extremity that is injured: in the arm, there is a better prospect of our being able to arrest the bleeding without having recourse to this extreme measure. *Secondary* hæmorrhage occurring in the course of treatment of a compound fracture of the lower extremity is far less serious than the primary. It has been arrested by pressure and bandaging, and in many cases by the ligature of the superficial femoral. Amputation, therefore, may be delayed in these cases until after the consecutive employment and failure of these two methods.

4. **Comminution or Splintering of the Broken Bone** is always a serious complication of a compound fracture. Here the case is very different from what occurs in similar circumstances in a simple fracture. Extensive suppuration will set in; the splinters, if completely or nearly detached, will lose their vitality, and not only produce all the irritation that would result from the exclusion of rough and pointed foreign bodies in the interior of a limb, but, if numerous, will, on their removal or separation, leave the member shortened and permanently deformed. The treatment of such cases will depend on the seat of the injury, and the extent of the comminution. Compound and comminuted fractures of the femur may, except when occurring in the upper third, generally be looked upon as cases for immediate amputation (*vide* p. 383); the only other exceptions being when the comminution is trifling, the splinters large, and lying in the axis of the bone, and the subject young. In the arm, forearm, and hand, and in the leg, provided the knee and ankle-joints be not involved, much may be done in the way of removing splinters of detached bone, and sawing off smoothly the rugged ends of the fixed fragments. The larger attached and "secondary" pieces should be left, as they will throw out callus, and become buttresses of support to the broken bone (*vide* p. 366). If a considerable quantity of splintered bone have been extracted from a limb, care must be taken that in putting up the fracture too complete extension is not maintained, lest a gap be left, which cannot be filled up by new bone, and a weakened limb result. It is better to place the bones in proper apposition, and to let the patient recover with a shortened but strong and otherwise useful limb.

5. The complication of a **bad Compound Fracture requiring Amputation low down in a limb, with a Simple Fracture high up,** is a serious one. The question that will here arise is: Should the amputation be performed above the compound and below the simple fracture, or above both? The answer to this must depend on the condition of the limb between the fractures. Suppose that there be a badly comminuted and compound fracture of the lower third of the leg, with a simple fracture of the middle of the thigh; or a crush of the hand or fore-arm, with simple fracture of the middle of the humerus; how should the Surgeon act? It appears to me that the proper course to adopt in such a case as this, would mainly depend on the conditions of the intermediate soft parts. If these be sound, free from extravasation, not contused or lacerated, the limb may with safety be removed just above the lower fracture, the upper fracture being treated on ordinary principles. But if there be extensive bruising of the limb with ecchymosis or deep extravasation between the fractures, then it would clearly be useless to amputate low down, as not only would the stump have to be formed of tissues in a state of disorganisation, but the inflammation set up at the seat of operation would speedily spread into the structures filled by extravasation, and, setting up unhealthy suppuration in these, would spread upwards to the higher fracture, converting it into a compound one of the worst kind. In such cases, therefore, where there is

extensive disorganisation of the intervening soft parts, it appears to me that the proper course for the Surgeon to pursue is to remove the limb at or above the line of the higher fracture.

6. The complication of **a Dislocation high up with a bad Compound Fracture low down**, as when the shoulder is dislocated, and the hand is crushed, is not so serious; the dislocation having been reduced, the limb may be amputated low down with safety. This practice I had occasion to adopt some years since in a young man who met with a bad crush of the hand and fore-arm, with dislocation of the humerus into the axilla, in consequence of the limb having become entangled in machinery. If, however, the compound fracture, unattended by any of the complications that have just been mentioned, occur in a young or otherwise healthy subject, we must, of course, attempt to save the limb, and shall generally succeed in doing so.

TREATMENT OF COMPOUND FRACTURES.—In the management of a compound fracture, more especially of the lower extremity, special apparatus, such as M'Intyre's, Liston's, or the bracket-splints, double inclined planes, swing-boxes, and fracture-beds, are often necessary, in order to obtain access to the wound, so as to dress it properly, and to place the limb in the best position for union. In many cases the starched or plaster bandage may very advantageously be used; but it requires caution, as swelling and consequent strangulation of the limb may take place under it.

There are several points that require special attention. These are: 1, the Reduction and the Management of any Protruding Bone; 2, the Management of Splinters; 3, the Closure of the Wound; and 4, the Subduing Consecutive Inflammation. It is in carrying out these indications that the whole treatment of the injuries is involved, in those cases in which the limb admits of being saved.

The **Reduction of compound fractures** must be accomplished with the same attention to care and gentleness as in that of simple ones. In the majority of cases, no great difficulty is experienced; and after reduction, the limb should be placed on a well-padded splint, properly protected in the neighborhood of the wound with oiled silk, so as to prevent soiling of the pads by blood and discharge. In some cases, however, considerable difficulty arises in the reduction, from the protrusion of one of the broken fragments which has been driven through the skin, at the time of the accident or by careless handling of the limb in carrying the patient, or else by the muscular contractions dragging the lower fragment forcibly upwards, and thus causing perforation of the integument. The protruded bone must, if possible, be gently replaced, by relaxing the muscles of the limb, and then bringing the soft parts over it. Sometimes, however, it is so tightly embraced by the skin, which appears to be doubled in underneath, that enlargement of the wound becomes necessary before it can be replaced. In other cases, again, reduction cannot be effected or maintained, unless the sharp and projecting point of bone be sawn off. This is best done with an ordinary amputating saw, the neighboring soft parts being protected with a split card; or else by passing the blade of a Butcher's saw under the bone and cutting upwards. The limb, as I have found in several cases in which it has been necessary to have recourse to this procedure, is not ultimately weakened or necessarily shortened by it.

After the reduction, the great object is, if possible, to convert the compound into a simple fracture by the **closure of the external wound**. No pains should be neglected to effect this desirable end. If

it can be accomplished, the tediousness and danger of the case are greatly lessened; the patient being saved from the whole process of suppuration, with all its attendant evils. But the chance of closing the wound in the soft parts will vary greatly in different cases, depending chiefly on the way in which it has been produced, whether by transfixion of the skin by the sharp angular fragment, or by the direct violence which has occasioned the fracture. If the wound be small, clean cut, and occasioned by the protrusion of the fragment rather than by the direct violence which occasioned the fracture, we may hope to succeed in our object by following Sir A. Cooper's recommendation of applying to it a piece of lint soaked in blood, or, what is better, saturated with collodion or with tincture of benzoin, and thus obtaining union by direct adhesion. The dressing should be left undisturbed until it loosens itself, at the end of a week or two, when the wound will probably be found to be closed. With the double object of closing the wound and of preventing decomposition of its fluids by the entrance of organisms floating in the air, Lister recommends the employment of the antiseptic method (p. 214), from which good results have been obtained. If the wound be large and lacerated, if a joint have been opened, if the wound have been inflicted by the same violence that has broken the bone, or if there be much bruising of the edges and surrounding tissues, with extravasation into the limb, suppuration must necessarily ensue, and thus direct union cannot be expected to take place. In these circumstances, it is in accordance with the best principles of surgery, not to follow the routine practice of attempting to close the wound, which cannot possibly unite by the first intention, but to treat it like any other contused wound, and apply carbolised water-dressing from the very first, so as to allow a vent for the discharges that will take place after the first four-and-twenty hours. If these be retained in the limb by the external wound being kept closed by any dressing, whatever its nature may be, deep infiltration of the areolar intermuscular planes will ensue, with much local tension and purulent infiltration, accompanied by severe constitutional irritation, followed probably by pyæmia. It is, I believe, in consequence of the free vent thus afforded to the discharges, and of their retention being avoided, that many of the worst-looking cases of compound fracture—especially of the leg—those in which there has been extensive sloughing of the soft parts around the wound, with exposure of the fractured fragments, eventually do the best. The danger in such cases is a remote one, from hectic and exhaustion; not an immediate and grave one, from erysipelas and purulent absorption, or septic poisoning, resulting from the infiltration of the limb.

After the position of the limb and the management of the external wound have been attended to, an endeavor must be made to **moderate the local inflammatory action**, and to **lessen constitutional irritation.** This is best effected by leaving the part undisturbed and untouched as long as possible. The great art in the successful treatment of compound fractures consists in not disturbing the limb or meddling with the wound. For days or even weeks the limb may sometimes advantageously be left without interference, when once it has been carefully put up. Should, however, much swelling have taken place, and the wound show no disposition to heal by the first intention, but become inflamed and sloughy, and should much inflammatory action be set up in the limb, this may be moderated by irrigation (Fig. 69), and by the application of cold evaporating lotions. The part should be elevated and but lightly covered, the bed-clothes being well raised by means

of a cradle, so as not to press on the limb, and to allow space for the evaporation of the cold lotion; care being taken, at the same time, that the bandages be applied very loosely, merely with a sufficient degree of force to retain the limb upon the splint, as inflammatory infiltration, that might rapidly induce strangulation of the part, is apt to ensue. The constitutional irritation must be subdued by the administration of opiates, together with an aperient, on the morning following the accident; and these medicines must be repeated from time to time during the first few days. Moderate and cooling regimen must be employed, and the patient be disturbed as little as possible. In many cases suppuration rapidly sets in, and, if the patient be addicted to drinking, the constitutional disturbance soon assumes the irritative form: in the circumstances, it is of great moment that support, and even stimulants, be freely given; they must be allowed from the very first, and increased in proportion to the depression of the patient's strength, or as symptoms of nervous irritation come on.

If there be much extravasation of blood into the soft parts, and bruising, great tension of the limb, followed by unhealthy suppuration and sloughing, will take place in the neighborhood of the wound; free incisions are then required to remove the tension and strangulation of the tissues, and, by letting out the broken-down blood and pus, to lessen the risk of the occurrence of gangrene. It is in these cases that much injury results from blindly following as a routine practice in all cases indiscriminately, the treatment which is undoubtedly of the highest value in some; viz., that of keeping over the wound any impervious dressing, whether antiseptic, plasters, or a pad of lint that has become hard and impermeable by imbibition of dried blood, with a view to closure by the first intention. The natural vent to the discharge through the external opening being interfered with, deep infiltration takes place through the areolar planes of the limb, and the most extensive local mischief may result, pyæmia being almost certain to ensue. As soon as suppuration is fairly established, a light poultice or thick oakum water-dressing should be applied, and the burrowing of matter prevented by making counter-openings where necessary, by the application of a compress, and by attention to the position of the limb. The fracture apparatus must be kept scrupulously clean, especially in summer; the bandages changed as often as soiled, and the pads well protected with oiled silk. During this period various complications, such as erysipelas, inflammation of the absorbents and veins, and low forms of pneumonia, are apt to occur, requiring special consideration and treatment; so also, if the discharge be abundant, hectic, with its sweats and gastro-intestinal irritation, may come on, requiring full support of the powers of the system, and the administration of the mineral acids and other remedies, according to circumstances. As the confinement to bed is necessarily very prolonged in these cases, often extending through many weeks and months, the state of the patient's back should be attended to, and he should early be placed upon a water-cushion, or hydrostatic bed, lest sores supervene. As the wound gradually heals, water-dressing must be substituted for poultices, so as not to sodden the parts and encourage suppuration, and, in time, the red or blue wash for the water-dressing. The bone will often be observed lying white and bare, bathed in pus, at the bottom of the wound. But even in this apparently unfavorable condition, it may recover itself: its vessels gradually depositing lymph in points on its surface, and this lymph becoming vascularised, so as to cover the bone with a layer of florid granulations; in other cases, necrosis to a greater or

less extent takes place, and perfect consolidation does not occur until the bone has separated. Curling has shown that those portions of necrosed bone are slowest in detaching themselves, which are connected with the lower fragment. In some instances a large quantity of provisional callus is thrown out, in which the necrosed bone is implicated; and then the process of separation becomes extremely tedious and protracted, and amputation may not uncommonly become necessary, from the powers of the patient being unable to bear up in so prolonged a struggle. So soon as some consolidation has taken place, the limb should be firmly put up in gutta-percha or leather splints, with a starched bandage, so as to enable the patient to be taken out of bed, to change the air of his room, and thus to keep up his general health. In fitting these splints, care must be taken to make an aperture opposite the wound, through which it may be dressed (Fig. 143).

Neudörfer has introduced a *dry* plaster of Paris dressing for compound fractures, especially those produced by gun-shot, and indeed, for all attended by excessive suppuration. From this means he derived the best possible results in the German wars of 1864 and 1866. His method is as follows. Beneath the seat of injury he places eight layers of linen cloth, and on this several pounds of dry gypsum are poured so that it lies under and around the fracture until there is a wall heaped up on each side of the wound, which is also covered in. The linen cloths are then brought over like a many-tailed bandage, and the whole is tied up by short lengths of bandage. As the plaster becomes impregnated with pus, it is scraped off, but the wound is on no account to be meddled with; new plaster is applied where the old, which has become pasty, has been removed. Neudörfer states that, when compound fracture has been treated by the fixed plaster bandage, this should be generally removed at the end of fourteen days. After this the dry method, as above described, may be applied, and no splint or other extending or containing apparatus is required. It may be observed that, as plaster of Paris does not "set" with albuminous fluids, it is not hardened by the pus, but merely absorbs it, becoming pasty.

The time required for the proper consolidation of a compound fracture varies greatly, according to the amount of injury done to the bones and soft parts, and the age and constitution of the patient. In the most favorable circumstances, it requires double or treble the time that is necessary for the union of a simple fracture. Much stiffness of the limb from rigidity of the muscles and tendons will continue for a considerable length of time; this may gradually be removed by frictions and douches.

Secondary Amputation may become necessary from the occurrence of traumatic gangrene, and then it must be done in accordance with the principles already laid down when speaking of that operation; but more frequently it is required from failure of the powers of the patient in consequence of irritative and asthenic fever, induced by general disorganization of the limb, or by hectic resulting from profuse suppuration and slow necrosis of the bones. In these circumstances, the constitution suffers from the local irritation which is the source of the wasting discharge: but, by removing this in time, and seizing an interval in which constitutional action may have been somewhat lessened, the patient's life will in all probability be preserved; the results of secondary amputation for compound fracture in these conditions being by no means unfavorable. Indeed, it is remarkable to see how speedily the constitutional irritative and hectic symptoms subside after the removal of the

source of irritation; the patient often sleeping well, and taking his food with appetite the day after the operation.

The proper period to seize for the performance of secondary amputation in the earlier stages of the injury is often a most critical point. As a general rule, it may be stated that, if the limb be not removed during the first twenty-four hours, eight or ten days must be allowed to elapse before the operation is done; as during that time constitutional irritation and suppurative fever are too general and active to render fresh shock to the system admissible. But when once the actions appear to tend to localise themselves, the suppuration becoming more abundant, the redness extending but slowly, and the constitutional symptoms merging into an asthenic form, then the limb may be removed with the best prospect of success. The more the action is localised, the greater is the chance of the operation succeeding.

In many cases the symptomatic and suppurative fever so rapidly becomes asthenic, that the Surgeon must seize the best moment he can for amputation. In these circumstances the operation is seldom very successful; the stump becomes sloughy, erysipelas or diffuse inflammation of the areolar tissue comes on, or symptoms of pyæmia set in, and the patient speedily dies. In other cases again, between the stages of the inflammatory and suppurative fever and the supervention of the typhoid symptoms, there is a marked interval of twelve or twenty-four hours, or even more. During this, the mischief may be looked upon as in a great measure of local character; the constitution has been disturbed by the setting up of the inflammatory action, but, this having terminated in suppuration, it has not yet become seriously depressed by the continued irritation of the discharge from the injured limb, or poisoned by the absorption of morbid matters from it.

The patient's powers must not, however, be allowed to sink to the last ebb before amputation is performed; as then, if the shock do not destroy life, intercurrent and visceral congestion, or some low form of inflammatory mischief, will not improbably prove fatal. Much as "conservative" surgery is to be admired and cultivated, and hasty or unnecessary operation to be deprecated, I cannot but think that the life of the patient is occasionally jeopardised, and even lost, by disinclination on the part of the Surgeon to operate sufficiently early in cases of compound fracture, and by two prolonged attempts at saving the injured limb.

The success of the operation will in a great measure depend upon the *after-treatment*. Large quantities of stimulants and support are often required in London practice to prevent the patient from sinking. I have frequently given with the best results, eight or ten ounces of brandy, twelve or sixteen of port wine, or two or three pints of porter, in the twenty-four hours after these operations, with beef-tea, arrow-root, or meat, if the patient would take it, and have found it absolutely necessary to do so to obviate death from exhaustion.

At a later period, when some weeks or months have elapsed, and the fracture has not united, the bones are necrosing, and the patient is being worn out by hectic, amputation must be performed at any convenient moment, and is often done with great success if it be not deferred till too late; for here the mischief is entirely local, and the constitution, suffering only by the debility resulting from it, quickly rallies when the cause of this is removed.

Bending, Rebreaking, and Resetting Bones.—It may happen, that at the end of two or three weeks a fractured bone is found in a position too faulty to be remedied by the natural process just described. At this

period the bond of union is soft and yielding, and the displacement, if angular, may usually be remedied by frequent re-adjustment of the apparatus, and more particularly by bandaging the fractured fragments in opposite directions, or by the use of pads and pressure thus exercised on the extremities of the broken bones. If this period be allowed to pass by, and the fracture be allowed to become consolidated, it may be found to be so *badly set* that it is necessary to forcibly bend or break the callus, in order to improve the condition of the limb. When the displacement is angular, and the consolidation not very firm, as is usually the case, this may be done readily enough; but if the displacement be longitudinal, and much time have elapsed since the occurrence of the injury, it will be difficult, if not impossible, to remove the deformity. The bending or breaking of the callus is best done under the influence of chloroform: the fracture being then put up again, speedy and perfect consolidation will ensue. In this way I have several times remedied a faulty position in fractured bones, although from six to ten weeks had elapsed from the occurrence of the injury

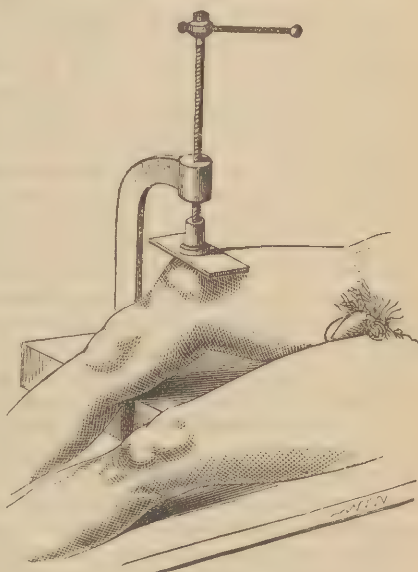


Fig. 146.—Butcher's Clamp for Re-fracturing Badly Set Bone.

In the majority of cases, the simple force exerted by the unaided strength of the Surgeon will suffice to rebreak the bone. But should several months have elapsed since the consolidation, the unaided strength will not prove sufficient. In such cases, Butcher has successfully employed a surgical clamp (Fig. 146), by the pressure of which the bone may be broken across at its displaced angle, even though the faulty union is of several months' duration.

Should the consolidation of the fracture be too firm to admit of re-bending, or re-breaking, *subcutaneous osteotomy* may be employed in some cases with advantage. The best instrument for use is Adams's narrow-bladed saw. With this I have divided the fibula in badly set Pott's fracture, where the bone had united at an angle pointing inwards, and thus throwing the outer edge of the foot upwards. The same operation may be applied to other bones, especially to those of the fore-arm.

A bone which does not appear to have been very skilfully set, and which presents a certain amount of deformity when the splints or apparatus covering it are removed, may gradually regain its proper shape if left to itself. This it does by the muscles of the limb moulding the callus whilst still somewhat soft and yielding into a proper shape. The callus may be quite strong enough to bear the weight and to maintain the length of the limb in its full integrity after the removal of all apparatus, and yet be sufficiently yielding to become slowly and gradually

shaped by the action of the muscles of the limb when they are left untrammelled by bandages.

But it more commonly happens that a limb which, when taken out of the splints at the proper period, appears to be straight and of good length, gradually yields under the weight of the body and the strain of the muscles: so that, at the end of a few weeks, great and most unsightly deformity occurs. In these cases the Surgeon is often unduly blamed; and to his unskilfulness is attributed that displacement which, in reality, is due to the faulty character of the callus. It must be remembered that there is every degree of firmness of the callus, from that which is of normal consistence to that which is quite unable to support the weight of the limb or body, and that yields more or less quickly under the pressure to which it is subjected.

Delayed Union.—Occasionally, more particularly in cases of fracture of the femur, tibia, and humerus, the union between the broken fragments is *delayed* several weeks beyond the usual period of perfect consolidation. This arises, in the majority of cases, from constitutional debility, rather than from local causes. Several cases of delayed union have been recorded in which repair readily took place after the employment of mercury. Indeed, in syphilitic subjects the constitutional taint should always be treated. A not unfrequent cause of delayed union is "meddling" with the fracture, changing the apparatus, removing splints or frequently testing the solidity. When it is found at the expiration of six or eight weeks after the occurrence of simple fracture that the callus is still yielding, the general health should be improved by tonics, change of air, &c., and the limb securely put up in starched or plaster of Paris bandages. Indeed, I believe that delayed union is much less likely to occur in patients who have from the first been treated by the starched bandage, and allowed to move about, than in those who have been confined to bed or rather to the house in the ordinary way.

Ununited Fractures and False Joints.—Some bones, when broken, very rarely unite by callus or plastic matter, their fragments merely being kept firm by the intervention of the aponeurotic structures of the part, as is the case with the patella. This, which is owing to a want of apposition of the fragments, and is dependent on the condition of the part, cannot be considered a diseased action.

It occasionally happens, however, in fractures of the shafts or of the articular ends of long bones, that proper union does not take place. This may be owing to one of four circumstances. 1. No uniting material of a stronger kind than a loose fibro-cellular tissue has been formed; 2. The plastic matter that has been thrown out has only developed into fibrous tissue, not having undergone osseous transformation; 3. True bony union has taken place, but, owing to some peculiar state of the patient's health, the callus has become absorbed, and the fracture loosened; or, 4. The fragments may be so widely separated that no uniting material could form.

In the first and third conditions we have an **Ununited Fracture**; the ends of the bone, which are rounded and eburnated, being merely connected by, and enveloped in, a loose fibro-cellular tissue.

In the second condition we have a **False Joint**, the ends of the bone being tied together by strong fibrous bands. The structure of these false joints, which has been carefully studied by Rokitansky, presents two distinct varieties. In the first, which partakes of the character of a hinge-joint, we find that the ends of the fracture are smoothed and rounded, invested with a dense fibrous periosteum, and united to one

another by thick bands of ligamentous tissue, in such a way as usually to admit of considerable lateral movement, though sometimes they are tolerably firm. In the other variety the joint partakes of the ball-and-socket character, usually to a very imperfect degree, but sometimes in a sufficiently well developed manner, one end of the bone being rounded and invested by a periosteum, the other cup-shaped, and covered by firm smooth fibroid tissue. The bones are united by a kind of capsule, in which a synovia-like fluid has occasionally been found.

The form that the false joint will assume depends on the action of the muscles which influence it. Thus, when occurring in the shafts of long bones, where it is subjected to movements of flexion and extension, it will assume the hinge-form; whilst, when it is seated in the articular ends, where it is more subjected to movements of rotation, it will affect the ball-and-socket character.

Non-union of fracture, whether resulting in false joint or in ordinary ununited fracture, is undoubtedly very rare. I have very seldom met with it in my own practice. The cases that have been under my care at University College Hospital have almost all been sent up from various parts of the country, and probably present but a very small proportion of the fractures that have occurred in the districts from which they have been sent. We probably exaggerate the frequency of non-union, if we say that it occurs in the proportion of one in a thousand cases of fracture of the limbs.

Causes.—The causes of ununited fracture and of false joint are *constitutional* and *local*.

In some cases the **Constitutional Cause** appears to be a *cachectic state* of the system occurring from some diseases, such as fever, scurvy, syphilis, or cancer, or from any depressing influence, in consequence of which there is not sufficient reparative power for the production or proper development of the plastic matter, by which the fracture should be united. If this have been deposited, it may, under the influence of these constitutional causes, again become absorbed, and the fracture may thus be loosened. But mere debility, independently, of blood cachexy, will not lead to want of union in a fracture. In fact, in many very weakly children, the scrofulous or phthisical, fractures will unite with the greatest readiness, and if union be delayed for a short time it will, on the restoration of health, readily take place. Indeed, the causes that, independently of local conditions, lead to non-union of a fractured bone, are most obscure. In many cases no constitutional cause for the want of union can be detected, the patient being in excellent health, strong and robust. In spontaneous fractures, union seldom takes place very readily or perfectly.

Pregnancy is said to have a tendency to interfere with the proper union of a fracture; this, however, I consider doubtful, as I have had under my care, and have seen, a considerable number of cases of fracture in pregnant women, which united in the ordinary time. Billroth has made a similar observation.

Age.—Failure of union in fractures is very rare in children, and when it occurs in them is seldom remediable, unless it be the result of neglect or of improper mechanical treatment. It is more common at the earlier adult and middle ages. Union will readily occur in aged individuals. Indeed, advanced age appears to exercise no adverse influence on the repair of fractures. I have on two occasions, in my own practice, known very firm and perfect consolidation of fracture of the shaft of the femur to take place in women of ninety years of age and upwards.

The **Local Causes** are various and important. The *anatomical condition* of the fragments, as regards their *vascular supply*, is perhaps that on which want of union is most immediately dependent. For proper union to take place, it is necessary that the callus be deposited from both sides of the fracture. If one fragment be so situated that sufficient blood is not sent to it for this purpose, not only may want of union, but necrosis, occur. This is exemplified in fractures of the superior articular ends of the humerus and femur. In intra-capsular fracture of the anatomical neck of the humerus, the globular head, being detached from all its vascular connections, may necrose. In intra-capsular fracture of the neck of the femur, the head of the bone, still retaining some vascular connection through the medium of the ligamentum teres, has sufficient blood furnished to it to prevent its death, but not enough to form callus—hence fibrous union takes place. In the shafts of the long bones, the degree of union will be dependent in a great measure on the conditions of the vascular supply to the fragments, through the medium of the nutritious artery. The influence of the rupture of the nutritious artery of the bone by the line of fracture running across it, and thus interfering with the vascular supply of one of the fragments, has been investigated by Gueretin; and the occasional occurrence of atrophy of the bone after fracture, has been shown by Curling to be dependent upon the interruption of the supply of arterial blood through this vessel. He states that the portion of bone below the entrance of the nutritious artery, or on that side of the foramen towards which the blood flows, being deprived of its proper vascular supply, undergoes certain changes; the medullary canal becoming expanded and the osseous tissue less dense. Gueretin has collected cases that tend to prove the direct connection between the occurrence of ununited fracture, and the want of proper arterial supply to one of the fragments. Thus, in the humerus the course of the nutritious artery is from above downwards; and of thirteen cases of ununited fracture, nine were found to be situated above the canal in which the vessel is lodged. In the forearm, where the nutritious artery passes from below upwards, of eight cases of ununited fracture, seven occurred below this vessel, and only one above. Adams has, however, shown that the number and size, as well as position, of the nutrient arteries, vary considerably; and hence the objection that non-union may occur in a fracture of any part of the shaft of a long bone, whereas the nutritious artery is only found at one spot, can scarcely be considered a very valid one.

Some bones are much more liable than others to disunion of their fractures. According to the statistics collected by Norris, it would appear that the femur, the humerus, the bones of the leg, and of the fore-arm, and lastly the lower jaw, are those in which ununited fractures most frequently occur, and that in the order which has been given. Hamilton states that in his experience the humerus is more commonly the seat of an ununited fracture than the femur; and my experience agrees with his.

One cause that may operate in leading to want of union in a fracture is the *application of a bandage* directly and too tightly to the limb. When this is done, the vascular supply to the broken bone is strangled, the muscles and soft textures want nutrition, and consequently, *a fortiori*, reparative actions are interfered with, and callus is not formed of proper consistence or in sufficient quantity for consolidation of the fracture.

The occurrence of ununited fracture is occasionally attributed to the *mobility or want of proper apposition* of the fragments which are so situ-

ated that, instead of the broken surfaces being in contact, rotation of the limb has caused the outer and periosteal aspects to touch. Doubtless, in some cases, it may be so occasioned: but I believe that these causes are not nearly so frequent in their operation as the constitutional and local conditions that have already been pointed out. The *interposition of a piece of muscle* between the fragments may prevent union. Of this I saw an interesting instance some years ago, in which want of union in a fractured femur was owing to the perforation of the vastus muscle by the upper fragment, and its entanglement between the broken ends. But it is very certain that, to whatever condition, local or constitutional, non-union of a fracture may be due, it is in very many cases quite impossible to assign to it any cause appreciable by the Surgeon.

The **Treatment of ununited Fracture** must not be conducted by local means only; *constitutional measures* should not be neglected. We cannot expect the formation of firm and strong callus unless the general health be in a satisfactory state. If callus have not been formed, or if, after formation, it have been absorbed under the influence of a cachectic state of the system, the improvement of the patient's health, at the same time that the fracture is put up again firmly, so that the ends of the bone are brought into close apposition, may bring about perfect union. In some instances of ununited fracture or delayed union in syphilitic subjects, union speedily takes place after the administration of some preparation of mercury or iodide of potassium, according to stage of the constitutional affection. I have had under my care at the Hospital, a man with ununited fracture of the femur from absorption of the callus four months after the occurrence of the injury, under the influence of incipient phthisis and debility induced by want of food; perfect consolidation of the fracture was produced by giving him cod-liver oil and good diet, with rest in bed and a starched bandage to the limb. Hence it is evident that impaired nutrition may prevent union, even after callus has been deposited, and that improvement of the nutritive activity of the body may of itself lead to consolidation of the fragments. If there be no very evident cause for the want of union, it will occasionally suffice to put up the fracture firmly in leather or gutta-percha splints, with a starched bandage, and then to allow the patient to move about upon crutches, so that his general health may not suffer, at the same time that a tonic plan of treatment is followed. I have seen several cases in which the want of union appeared to have resulted from too long confinement of the patient to his bed, and the consequent impairment of his health, consolidation taking place when a more favorable hygienic system was enforced. This simple plan can, however, only be useful if but a short time, at most some months, have elapsed from the occurrence of the injury. In some cases, the empirical administration of mercury is attended with success. In a case of ununited fracture of the humerus that was admitted into the University College Hospital under Liston, fifteen weeks after the occurrence of the injury, union was induced within a month by putting up the splints, and salivating the patient. When the want of union arises from malignant disease, nothing can be done.

At the same time, with appropriate constitutional treatment, suitable *local means* must be employed to secure steady coaptation of the fragments. In the upper extremity, this may usually be done by means of splints of an ordinary character. In the leg, the starched or plaster of Paris bandage will be found to be especially serviceable. In the case of ununited fracture of the thigh, special apparatus will be required to secure complete fixity and steadiness of the limb. For this purpose, the limb

should be put in an apparatus. consisting of an outer and an inner iron rod having hinge-joints opposite the hip and ankle, and attached above to a strong pelvic band, and below to the sole of the foot. The thigh part should be provided with well-padded splints, which may be screwed down in opposite directions against the two fragments, so as to hold them firmly in contact. This instrument should be worn for several months; and by it Smith, of Philadelphia, has succeeded in curing ten out of fourteen ununited fractures in the lower extremity. One great recommendation is, that this plan of treatment is entirely devoid of danger, and enables the patient to take exercise whilst under treatment. In cases where there are much shortening of the limb and riding of the fragments, which are especially apt to occur in the thigh, it will be necessary to employ extension of the limb as well as compression of the fragments against one another. This extension may be made by the lateral iron rods of the above-described apparatus being constructed so as to slide, by means of a rack-and-pinion or screw mechanism, by which the limb may be gradually lengthened to any required extent (Fig. 147).

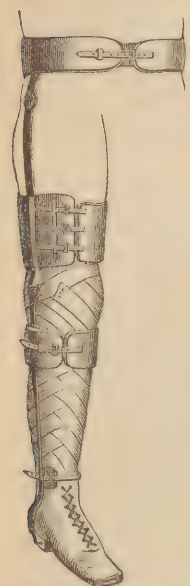


Fig. 147.—Apparatus for Ununited Fracture of Femur.

When the failure of union has become very chronic, and a **False Joint** has been formed, it will be necessary to employ operative procedure before union can be attained. All operations that are undertaken in these cases are conducted on one of two principles; either, 1, *to excite such inflammation in the false joint* and neighboring tissues, as will lead to the formation of lymph capable of undergoing osseous transformation; or else, 2, *by removing the false joint altogether*, to convert the case into a recent compound fracture, and to treat it as such an accident. It can be easily understood that operative procedures conducted on these principles are too serious to be lightly undertaken, or to be had recourse to until other measures have failed, the mortality following them being, even according to public statistics, considerable, and probably very much greater than has been laid before the profession.

1. Among the first set of operations—those that have in view the **Excitation of sufficient Inflammation to cause Deposit of proper Plastic Matter,**—the simplest procedure consists in the **introduction of acupuncture needles**, or in the **subcutaneous section** of the ligamentous band with a tenotome. In this way I have known union effected in a patient of Liston's, who had a false joint in the shaft of the femur; though not until after the fracture had been converted into a compound one, and much danger and suffering incurred. Four years after the consolidation of the ununited fracture, the patient was readmitted into the Hospital, under my care, with fracture of the same bone two inches lower down than the former injury; on this occasion, union took place in the usual manner and time without any difficulty.

The **introduction of a seton** across the false joint, though occasionally successful, is apt to give rise to dangerous and even fatal results, from arterial hæmorrhage, erysipelas, diffuse inflammation, and suppuration of the limb. The threads must not be left in beyond a few days,

when sufficient action will have been induced. A modification of the seton consists in passing a silver wire around the fracture, and gradually tightening this, so as to cut through the false joint at the same time that inflammatory action is excited in it. In performing this operation, it must be borne in mind that large arterial branches, and even the main trunk, especially in the thigh, may become firmly attached to the callus, so that unless care be taken they may readily be wounded.

Percussion of the ends of the bones has been successfully employed in these cases by Mr. H. O. Thomas. The method consists in protecting the skin at the seat of fracture with a piece of felt, and then percussing forcibly the ends of the broken but ununited bone by means of a copper mallet. The percussion under anæsthesia may be continued for several—as many as ten—minutes; it may only be required once, or may need several repetitions. The effect is a good deal of local swelling and irritation. The limb should be put up firmly as for recent fracture, and a cure may be expected in from four to six weeks.

Dieffenbach has proposed to excite the requisite degree of inflammation by **driving, with a mallet, three or four conical ivory pegs** into holes bored by means of a gimlet or drill into the ends of the fractured bone, which are exposed for this purpose. The awl, or drill, may be worked with the Archimedean screw, and will then be found to penetrate much more easily. Points of different sizes may be used, and altogether this instrument will be found by far the best (Fig. 148). The

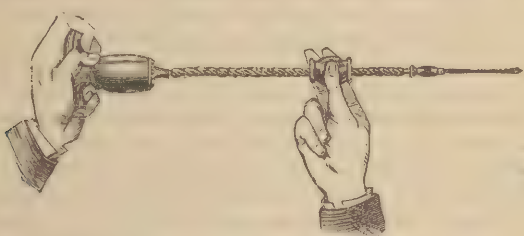


Fig. 148.--Archimedean Drill for perforating Bone.

soft parts are then to be laid down, and after a few weeks the pegs, which have loosened in consequence of the removal of absorption of their ends, should be taken out. It is not necessary or even desirable to attempt to pin together the ends of the broken bone, but merely to introduce the pegs into the extremities of both fragments near to the seat of fracture. It is, however, especially in ununited fractures of the humerus that this can be successfully done, the irritation of the pegs appearing to occasion an effusion of a large quantity of callus sufficient for the consolidation of the fracture. This operation I have practised with great success in several instances of ununited fracture of this bone. In one case that was under my care, there was a false joint at the junction of the upper and middle thirds of the bone, complicated with an elbow ankylosed in the straight position; here, after flexion of the stiff elbow, perfect consolidation of humerus was effected by the use of five pins. In the ununited fractures of the bones of the leg and fore-arm, it is also likely to be serviceable, but in the femur not so much so. Indeed, in the cases of ununited fracture of this bone, I have known more failures than successes after this operation.

2. The operation of **Removing the False Joint** may be performed by cutting down upon it, and resecting the ends of the bones, or else by

destroying the articulation with caustic potash. The excision of a false joint is necessarily dangerous, and by no means successful; erysipelas, phlebitis, and diffuse suppuration of the bone, occasionally supervening. It should only be done when there is much overlapping of the fragments. Of thirty-nine cases collected by Norris, in which the ends of the bones were either resected or scraped, twenty-four were cured, seven derived no benefit, and six died. In those cases of the operation that are successful, some shortening of the limb must be expected to result; and, if the fracture be very oblique, it will of course be impossible to remove more than a very limited portion of bone, and, consequently, very perfect union can scarcely be anticipated. The application of caustics to the exposed bones is so coarse and uncertain a method as to find but little favor amongst Surgeons of the present day. Professor Nussbaum, of Munich, has recently performed transplantation of bone in a case where a portion of the ulna was lost as the result of a gun-shot injury. A shell of bone and periosteum was stripped off the adjacent bone and laid into the gap that was left after the removal of the fractured ends and the intervening fibroid tissue, care being taken not to sever the periosteal connection between the transplanted shell and the body of the bone. Operations for ununited fracture very rarely succeed in children when the disunion is owing to other than local causes. They may succeed in old people: I have united a femur that had been disunited for nearly twelve months in a man between sixty and seventy by Dieffenbach's method. The more thickly the bone is covered by soft parts, the more likely will an operation be to succeed. Hence the humerus and femur are more favorable for operation than the tibia.

On reviewing the various methods that have been recommended for the re-establishment of union between the separated fragments, it would appear that the excitation of proper inflammatory action by the introduction of the seton, or by driving in ivory pegs, promises the most satisfactory result. It is by no means necessary, or even advisable, to remove the fibrous band that intervenes between the fragments in cases of false joint; for, if the proper amount of inflammatory action be set up, this either undergoes osseous transformation, or a sufficient quantity of callus is thrown out around it to consolidate the fracture. It is very important that the pegs should be removed from the bone, for, if they be allowed to remain after the bone has united, tedious suppuration and necrosis of the bone may result. If union should fail to be accomplished, and the false joint were situated in the femur or the bones of the leg, the limb might be so useless and cumbersome to the patient, that amputation might be required as a last resource.

CHAPTER XXI.

SPECIAL FRACTURES.

In considering the nature and treatment of fractures of particular bones, we shall at present confine our remarks to Fractures of the Bones of the Face, Trunk, and Extremities. Injuries of the Bones of the Head and Spine derive their principal interest and importance from their complication with lesion of the internal and contained organs; hence the consideration of these will be deferred to special Chapters.

FRACTURES OF THE BONES OF THE FACE.

Nasal Bones.—These, being thin as well as exposed, are not unfrequently broken. When fractured, they may remain undisplaced, but they are more commonly depressed; the ridge of the nose being beaten in. The swelling and ecchymosis that usually attend their fracture often render detection difficult, and must be reduced before any treatment can be adopted for the removal of the deformity. The depressed bone should be raised with the broad end of a director, or by the introduction into the nostril of a pair of polypus-forceps, which, expanding on being opened, push the bone into proper position. A flaccid vulcanised India-rubber dilator, of proper size and shape, introduced empty, and then expanded with water, will be found to answer admirably in restoring the shape, and removing the disfigurement of a "broken nose," even though some weeks have elapsed since the injury.

If the **septum** alone be broken, the same treatment must be adopted; the nose being supported and moulded into shape. As a rule, after it has been replaced, the position is maintained; but in some cases, where there is a tendency to sinking of the soft parts of the nose, the introduction of a plug of oiled lint round a quill, left open for breathing, will be required to replace and retain the organ in proper shape and prominence. The hæmorrhage, which is usually rather abundant in the first instance, may be stopped by the application of ice; but occasionally the nostrils require plugging, in order to prevent it from continuing to a dangerous extent. If the **lachrymal bone** be broken together with the nasal, the ductus ad nasum may be obstructed, and the course of the tears diverted. In an injury of this kind, I have seen extensive emphysema of the eyelids and forehead occur on the patient attempting to blow his nose. In some cases, the injury inflicted on the nasal bones extends through the ethmoid to the base of the brain, and may thus occasion death. This I have seen happen from a severe blow on the face with a piece of wood.

Malar and Upper Jaw Bones.—These are seldom broken unless great and direct violence have been employed; and their fracture is usually accompanied by external wound, as in gun-shot injuries of these parts. More commonly the alveolar processes are detached, and the teeth loosened. The treatment then consists in binding the teeth together with gold wire. In fractures of the *zygoma*, the fragments may be driven into the temporal muscles, and produce so much difficulty in mastication as to require removal.

In some rare cases, **all the bones of the face** appear to have been smashed, and separated from the skull by the infliction of great violence. Thus, South relates the case of a man who was struck on the face with a handle of a crane, and in whom all the bones were separated and loosened, "feeling like beans in a bag." Vidal records the case of a man who, by a fall from a great height, separated all his facial bones. A patient was admitted into University College Hospital under my care, who had fallen thirty feet over the balusters of a spiral staircase. He had in some way struck his face, either on reaching the ground or in the fall. He lived only about two hours after admission. On making a *post mortem* examination, the following injuries were found. The lower jaw was fractured through the ramus on the left side, and through the body between the molar teeth on the right side. In the upper jaw a transverse fracture ran completely across from one side of the face to the other, at about the level of the inferior border of the anterior nares. It passed through both superior maxillary bones, the vertical part of the

palate bones, both pterygoid processes of the sphenoid bone on both sides, and the vomer; so that the whole of the alveolar portions of the superior maxilla and the palate formed one piece. This was displaced backwards into the pharynx. The zygoma was fractured on both sides; and a vertical fracture ran on each side from the margin of the orbit through the walls of the antrum; so that on each side there was one huge fragment composed of part of the zygoma, the malar bone, and the part of the superior maxillary bone with which it is articulated. The nasal bones, the nasal processes of the superior maxillary bones, the os unguis on each side, and the ethmoid, were smashed into numerous small fragments. There was no fracture visible from the interior of the skull. There was no other injuries of importance found.

In **Gun-Shot Injuries of the Face**, there is usually great splintering of the bone. As, however, the vitality of the part is great, necrosis is not so likely to ensue here as elsewhere; and the partially detached and loosened fragments may accordingly be put back into position, and will usually recover themselves. There are, however, two principal dangers in these cases; viz., hæmorrhage, either primary or secondary, and abundant fetid muco-puriform discharge. The primary hæmorrhage usually ceases spontaneously, or on the application of cold. If secondary, it may be arrested by cold, by plugging, and by pressure; or, if continuous, and from deep sources, it may possibly require ligature of the carotid. The fetid secretion from these wounds is not only a source of great discomfort to the patient, but of positive danger, as, by its miasmatic effluvia, or by finding its way into the stomach, it may occasion typhoid symptoms. This risk is best obviated by scrupulous attention to cleanliness, by repeated injections with warm water, chlorinated lotions, or a solution of permanganate of potash.

Lower Jaw.—This bone is frequently broken, owing to its prominent situation; though its arched shape enables it to resist all but extreme degrees of violence. Fractures of this bone are often compound, sometimes in consequence of external wound, but more frequently from the laceration of the gum causing them to communicate with the external air. Not unfrequently, they are comminuted.

Fracture of the lower jaw may occur in various situations. I have seen it most frequently in the **body of the bone** near the symphysis, extending between the lateral incisor and the canine teeth. The **symphysis** itself is not so commonly fractured, the bone being thick in this situation. The **angle** is more frequently broken. The **coronoid process** can only suffer fracture from the most severe and direct external injury, as from a bullet-wound. The **neck of the condyle** is occasionally broken across.

Fractures near the symphysis are usually vertical. Those near the angle are commonly oblique from before backwards, so that a long spiculum of the outer table is connected with the upper fragment.

These fractures are sometimes double, either symmetrically so, or more frequently one on the side near the symphisis, and the other near the angle.

The **Signs** of fracture of the lower jaw are very obvious. The great mobility of the fragments, the crepitus, the irregularity of the line of teeth and of the arch of the jaw, laceration of and bleeding from the gums, and dribbling of saliva, indicate unequivocally the nature of the injury. The displacement and mobility of the fracture are greater, the nearer it is to the symphysis. If the bone happen to be broken on both sides of this line, the middle fragment is much dragged out of place by

the depressor muscles attached to it; indeed, in all double fractures the displacement is very great. In fracture about the angle and lower part of the ramus, the deformity is not so great, owing to the muscles that coat and protect each side of the bone in this situation preventing the fragments from being displaced. When the neck of the condyle is broken through, that process, coming under the influence of the external pterygoid muscle, is often a great deal displaced.

When the fracture is near the symphysis, the dental canal escapes; but when it is further back in the body of the bone, and especially near the angle, the canal must necessarily be implicated. It is remarkable, however, that the inferior dental nerve usually escapes injury or division in many cases altogether, in others for several days, until, perhaps, owing to great displacement or to some effort of reduction, it may be torn across. When this happens, the soft parts of the lower lip, supplied by the mental branch of the inferior dental, are necessarily for a time deprived of sensation, but they soon recover. I have never known any permanent mischief from this cause, or from the hæmorrhage following laceration of the inferior dental artery.

The **Treatment** is simple enough in principle, though often not very easy of accomplishment. It consists in maintaining the parts in apposition by suitable apparatus for four or five weeks, during which time mastication must be interdicted, the patient living on sops, soups, and fluid nourishment of all kinds, and talking being prohibited. The apparatus that commonly suffices consists of a gutta percha splint (Fig. 149), moulded to the part (Fig. 150), properly padded, and fixed on with a

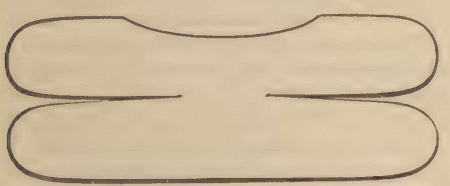


Fig. 149.—Gutta Percha Splint: Original Shape.

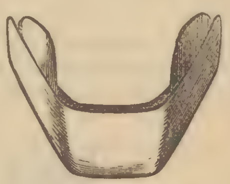


Fig. 150.—Gutta Percha Splint, moulded to Shape of Jaw.

four-tailed bandage; the two fore-ends of which are tied behind the neck whilst the other two are knotted over the top of the head (Fig. 151). When the ramus is broken, the side of the gutta percha cup splint should be made proportionately long. The teeth in these cases require special attention. Any that are loosened must be left in, as they will soon contract adhesions, and fix themselves firmly; and, if necessary, they may be tied to the sound teeth with silver wire, or dentist's silk. But, although metallic wire is occasionally needed for the purpose of more accurately fixing the fragments, care must be taken that any tooth that may have been forced out of its alveolus and dropped between the fragments be removed from this situation; in one case where a tooth was overlooked in this position, no union of the fracture took place till it had been removed. When depression, especially near the symphysis, is considerable, a clamp apparatus which fixes the chin and line of teeth, invented by Lonsdale, answers the purpose of steadying the fragments extremely well. When the fracture is double, one fissure occurring near the symphysis, the other near the angle, there is often very considerable difficulty in bringing the fragments into anything like good position, without the aid of some special apparatus. In such cases a

metal plate should be accurately moulded and fitted to the teeth, and attached to Lonsdale's clamp or to a stem, and fixed to a horse-shoe shaped gutta percha splint placed under the jaw, so as to keep the whole steady and solid. Union generally takes place readily and very per-

Fig. 151.
Apparatus applied to Fracture of Lower Jaw.

Fig. 152. Fig. 153.
Thomas's first method of Uniting Fracture of the Lower Jaw. A, B, wires passed through drill-holes and coiled by Fig. 153, the key.

fectly in fractures of the jaw, though it is somewhat slow at first, and the fragments continue mobile for some weeks. But the vascular supply of the bone is abundant, and reparative action correspondingly perfect.

In all compound fractures of the lower jaw, H. O. Thomas strongly advocates drilling the bone on each side of the fracture, and fixing the fragments by means of silver wire. He finds that the ordinary cross-twist does not hold; he therefore coils the wire at each side (Fig. 152, 154). In order to facilitate this operation, he has devised a set of instruments, comprising a tubular needle to return the wire, and a key for coiling it. (Fig. 153).

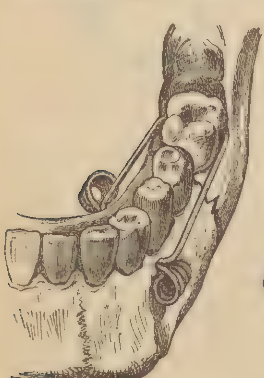


Fig. 154.—Thomas's second mode of uniting Fracture of the Lower Jaw by Twisted and Coiled Wire.

Fig. 155.—Form of the Coil of Wire.

In **Fractures of the Body of the Lower Jaw by Gun-shot Injury,** there is great comminution and splintering of the bone, followed by copious and fetid discharge, which, being in part swallowed, may reduce the patient to a state of extreme debility, or induce symptoms of a typhoid character, which may prove fatal. In these cases, Dupuytren recommends the lower lip to be cut through, the splinters taken away, and, if necessary, a portion of the bone resected, so as to convert the wound into one similar to what results after the partial removal of the lower jaw for disease of the bone.

Fracture of the Hyoid Bone is of very rare occurrence; and, though

usually the result of direct violence, as a forcible grasp, has been seen by Ollivier D'Angers to occur from muscular action. The signs are always very obvious. The fragments form a sharp salient angle: there is much pain and irritation, increased by speaking and deglutition. There is usually salivation; and considerable difficulty in breathing may be present. *Reduction* is accomplished by pressing the fragments into apposition, either externally or by passing the finger into the mouth. Should one piece of the bone be driven much in, it might possibly require to be drawn forwards with a tenaculum. The head should then be fixed with a stiff pasteboard collar to prevent displacement.

FRACTURES OF THE BONES OF THE CHEST.

FRACTURE OF THE RIBS AND COSTAL CARTILAGES.—These injuries may occur in two ways: 1st, from direct violence, the part that is struck being driven in towards the thoracic cavity, and thus broken; 2d, the fracture occurs from indirect violence, the forepart of the chest being forcibly compressed, so that the rib is bent outwards and snaps. When the injury is the result of direct violence, and the broken fragments are forced in, the pleura, lung, liver, or diaphragm, may be wounded, thus giving rise to the most serious and fatal consequences, such as hæmorrhage, emphysema, and inflammation of the parts injured. When it is occasioned by indirect violence, as the fracture takes place in a direction outwards, the thoracic organs may be contused and thus injured, but they are not liable to be punctured by the fragments. In some rare cases, the ribs have been known to be broken by the violent contraction of the abdominal muscles during parturient efforts.

Fractures of the ribs may be *single; multiple* when several, or even the whole of the ribs on one side, or several on both sides, are fractured; *simple*, as in ordinary violence; and *compound*, as in gun-shot injuries; or when the broken ends are driven into the lung.

Any one of the ribs may be broken, and frequently several are fractured at the same time. The middle ribs, from the fourth to the eighth, are those that most frequently give way, being most exposed, and at the same time fixed. The first and second ribs are seldom broken, being protected by the clavicle and shoulder. When they are fractured it is usually the result of gun-shot, or, if from some of the ordinary accidents of civil life, the clavicle will be broken as well. But this is not an invariable complication. I have seen fractures of the first two ribs from a fall, without any injury to neighboring bones. The fracture is always very dangerous, on account of the liability to injury of important subjacent structures. The lower ribs, being less firmly fixed than the others, commonly escape, unless very great and direct violence be inflicted upon them. Any part of a rib may be broken by direct violence; but when the fracture is the result of compression of the chest, it is usually the point of greatest convexity or the neighborhood of the angle of the rib that gives way. These indirect fractures most commonly occur in elderly people, in whom the elasticity of the thoracic parietes has lessened as the result of age.

Symptoms.—The chief symptom is a sharp pricking and catching pain at the seat of injury, increased by breathing deeply, or by coughing. In order to avoid this, the inspirations are shallow, and the breathing is principally diaphragmatic and abdominal. On laying the hand over the seat of injury, and desiring the patient to cough, crepitus may often be felt; and in most cases this is audible on applying the ear to the chest.

Occasionally the outline of the rib will be found to be irregular; and in some instances, where several ribs are broken, the whole side of the chest is flattened and depressed. Besides these local symptoms, special complications resulting from laceration of the pleura and lung, such as hæmoptysis, pneumothorax, or emphysema, may occur. These complications are much less frequent than might *à priori* be supposed, owing to the fracturing force being usually indirect, causing the rib to bend outwards, and thus to break away from, instead of into, the chest. The danger of fractured ribs depends on the thoracic complications, and these will chiefly be occasioned by one of two conditions: either by the forcible driving in of the fractured end of one rib, so that the pleura and lung become wounded by the sharp and ragged fragment; or else by a large number of ribs being broken by a severe squeeze of the chest, and the thoracic organs injured by the general compression. It is surprising, however, what an extent of injury of this kind may take place without serious consequences. I have had under my care a young man, who, in consequence of a crush of the chest, in a railway accident, had the upper seven ribs broken on the right side, and the lower five on the left, the chest, especially on the right side, being greatly flattened; he recovered without a bad symptom. In gun-shot injuries of the chest, with splintering of the ribs, there is always wound of the contained organs, which becomes the main source of danger to the patient and of attention on the part of the Surgeon.

Treatment.—In treating fractured ribs, the Surgeon need not concern himself so much about the union of the fracture, as about the prevention of pain to the patient in breathing, and of the subsequent occurrence of serious inflammation or other mischief within the chest.

Any displacement that may exist usually remedies itself. The chest-wall, even when extensively flattened, gradually expands under the influence of the respiratory movements. If, however, a portion of the rib continue depressed, it had most certainly better be left so: the suggestions that have been made for elevating these fractures by means of sharp hooks and screw-probes, being more likely than the continuance of the depression to occasion serious mischief to the contents of the thorax. In order to prevent undue motion of the broken bone and consequent irritation produced by its puncturing the pleura, or lung, the movements of the injured part of the chest may be restrained by the application of a broad flannel roller, or of a laced napkin round it. Instead of, or in addition to these means, it will be found most useful to apply a roll of adhesive plaster round the chest. The plaster must be about a foot in width, and should be sufficiently long to make one and a half turns round the body. It should be applied very tightly, and may be left on for ten days or a fortnight, when it may require reapplication. It supports the chest more firmly and evenly than an ordinary bandage, affording the patient great comfort. There is always a considerable amount of callus thrown out in the repair of fractured ribs, on account of the constant movement that necessarily takes place between the broken ends in respiration. In some cases, however, more particularly in those in which the fragments are driven inwards, it will be found that the constriction of the chest, by bandage or plaster, becomes unbearable to the patient, producing great pain and intense dyspnœa. In these circumstances all constriction must be removed, and the patient be allowed to breathe easily, but he must be confined to bed. If the lower ribs be broken, the diaphragm may become irritated by the projection inwards of the fractured bone; and if the plaster and bandage be applied too

tightly, spasmodic action of that muscle may ensue, occasioning distressing hiccup and dyspnœa.

In gun-shot injuries of the chest with splintering of the ribs, all broken spicula of bone must be carefully picked out, and the wound lightly covered with water-dressing. In such cases, the grave injuries usually sustained by the intrathoracic organs will absorb the Surgeon's attention; and for their treatment I must refer to Chapter XXVIII.

The prevention of inflammatory action must be attempted, by the employment of bleeding if necessary; but certainly by the adoption of a spare diet and complete rest. Any complications that may occur, such as emphysema, or inflammation of the lungs or pleura, must be treated in accordance with the principles that will be laid down in speaking of Injuries of the Chest generally.

It occasionally happens that fracture of one or more of the **Costal Cartilages,** especially the fifth, sixth, seventh, or eighth, is produced by direct violence. They may be separated from their junction with the rib, or broken across the middle. The existence of fracture may be determined by the pain on pressure, mobility, and irregularity at the seat of injury. The same treatment is required for this fracture as for a broken rib; the broken cartilage most commonly uniting by a bony callus which surrounds the fractured ends.

Fracture of the Sternum.—The sternum is not often broken. Its fracture usually occurs from very severe and direct violence; and when this is applied on the forepart of the chest, the ribs or costal cartilages are more liable to suffer. The elastic support furnished to the sternum by these structures, explains in a great measure the rarity of its fracture. It may also be produced by violent bending forward of the body after the spine has been broken. It has been known to be broken, though very rarely, by violent straining muscular efforts during parturition. Its fractures are always transverse, usually single, but sometimes multiple. I have seen it broken into three nearly equal fragments by a fall from a scaffold. The displacement of one of the fragments is sometimes considerable; but even if it be not, the very superficial situation of the bone will always enable the Surgeon to judge of the exact nature of the injury it has sustained, the signs which resemble those of a fractured rib.

The **Treatment** must be conducted on the same principles as in a broken rib, and presents nothing deserving of special attention. Indeed, when fracture of the sternum occurs from external violence, it is commonly associated with fracture of the ribs, near the angles; and then the chest-bandage or plaster answers equally for both injuries. Should the sternum be broken during parturition, the patient should be made to sit up in bed, with the shoulders supported and leaning forwards slightly, so as to take off the tension of the abdominal muscles. If a portion of broken sternum be depressed, it should be left undisturbed. It will give rise to no serious inconvenience, while any attempt to raise it by surgical interference may be attended with the greatest danger.

FRACTURES OF THE UPPER EXTREMITY.

The Clavicle is more frequently broken than any other bone in the body. For this there are three reasons. First, it is exposed to the influence of direct violence; secondly, it receives all shocks transmitted through the shoulder in a horizontal direction to the trunk; and thirdly, being the only osseous support of the upper extremity, it receives, by

transmission through the scapula, every shock that is communicated to the hand when the arm is extended. Notwithstanding its exposed position, it is comparatively seldom broken by direct injury. The great majority of the fractures occur from indirect violence, as falls on the shoulder and the hand. This bone would be more frequently broken that it is, were it not that it resembles two segments of a circle looking in opposite directions, so as to form an S shape, which admirably enables it to withstand indirect violence (Fig. 156).

The clavicle is occasionally fractured by muscular action—more particularly from the swing of the arm, as in a back-handed blow. When the accident occurs from this cause, it is usually about the middle of the bone, and on the right side.

Compound fracture of the clavicle can only occur from bullet-wounds, or some similar severe and direct injury inflicted upon the bone.

Fractures from direct violence are usually transverse, and often comminuted. From indirect violence they are oblique. The latter are attended by much more deformity than the former.

Fractures of this bone in infants and young children are usually transverse; sometimes the bone is merely bent, or is fractured on one side only. The injury is usually occasioned by falling out of bed. Such accidents are frequently overlooked by careless nurses; but, the child crying whenever the arm is moved, attention is directed to the part, and the Surgeon then finds some deformity, with a node-like swelling above the middle of the bone.

Both clavicles are occasionally, though rarely, fractured. In one such case, which was under my care at University College Hospital, the patient, a young man of 20, had sustained this injury, and had twelve ribs broken as well, in a railway accident. Notwithstanding this serious complication, he made an excellent recovery.

Complications.—In simple oblique fracture of the clavicle, there is rarely any complication of importance. But when the fracture is the result of direct violence, the same force that breaks the bone may seriously injure subjacent parts of importance. The subclavian vein may be compressed or wounded, or the brachial plexus of nerves may be compressed or torn. The first rib may be broken by the crushing violence, and the pleura wounded.

The clavicle may be fractured at any point between the ligaments at its acromial and sternal ends. 1. Most frequently the **Great Convexity** is broken; the bone bending here when pressed upon from its extremity, the curve becoming increased, and at last giving way. This fracture may arise from direct violence, but usually is the result of falls on the hand or shoulder. 2. It may be fractured nearer the acromion, between the two **Coraco-clavicular Ligaments.** 3. Its **Tip** may be broken off externally to the outermost point of insertion of the trapezoid ligament, between it and the acromion. These latter two fractures can scarcely occur from indirect, but are almost always the result of direct violence. 4. The clavicle may be broken internally, that is, to the **Sternal Side of the Rhomboid Ligament,** usually about three-quarters of an inch from its sternal articulation. The injury is of very rare occurrence. R. W. Smith, although admitting its possibility, states that there is no actual proof from dissection of its having occurred.

The **Signs** will depend upon the seat of fracture. When the bone is broken *between the conoid and trapezoid ligaments*, there is little, if any, displacement, but pain on pressure, some crepitus on moving the

Fig. 156.—Sound Clavicle.

Fig. 157.—Fracture of Clavicle outside of Trapezoid Ligament.

shoulder, and slight irregularity in running the finger along the bone, are usually present. When the fracture is *external to the trapezoid ligaments*, there is a remarkably oblique displacement of the scapular fragment, the articular surface of which is turned forwards and inwards, with a slight inclination downwards, nearly at right angles to the rest of the bone, apparently by the dragging of the weight of the shoulder, the point of which with the scapula, is rounded forwards (Fig. 157). When the fracture occurs *about the middle of the bone*, or at any part on the *sternal side of the sternal ligaments*, there is a remarkable degree of deformity, owing to a triple displacement of the inner end of the outer fragment inwards, downwards, and slightly backwards, while the outer end is rotated forwards. This displacement is due to two causes, one of which is mechanical and the other muscular. The displacement downwards is owing to the weight of the arm and the action of the deltoid muscle dragging the fragment down. The displacement inwards, with rotation of the shoulder forwards and pointing of the sternal end of the outer fragment backwards, is due to the action of the pectoralis minor, and the subclavius, and the other muscles that pass from the front and sides of the trunk to the humerus and scapula, drawing the scapula and the whole of the upper extremity forwards and inwards towards the mesial line, when the support of the clavicle is removed. The outer extremity of the inner fragment appears to be elevated, the skin being drawn tensely over it; but this is rather owing to the depression of the outer portion of the bone; it is usually kept fixed by the antagonism between the sterno-cleido-mastoid and great pectoral muscles. It may, however, in some cases be raised. This is when the clavicular portion of the sterno-cleido-mastoid muscle is unusually strong, and when the fracture has taken place just outside its insertion into the clavicle; or it may be raised and pushed forwards, by the inner end of the outer fragment getting below or behind it. On looking at a patient with fracture of the clavicle in this situation, the nature of the injury is at once evident. The flattening of the shoulder, and the approximation of its point towards the sternum; the great prominence formed by the outer end of the inner fragment, over which the skin is tightly stretched; the sudden depression under this, and the crepitus, which can be easily induced by elevating and rotating the shoulder at the same time that the elbow is pressed to the side, indicate in the most unequivocal manner the nature of the injury. The attitude of the patient is remarkable: he sits, leaning his head down to the affected side, so as to relax the muscles, and supports his elbow and forearm in the sound hand, in order to take off the weight of the limb.

When the fracture occurs near to the sternal end of the bone, it is usually, if not always, transverse. If it occur internally to the rhomboid ligament, the outer fragment is displaced forward, but remains in the same horizontal level as the sternal fragment. If the triple displacement of the outer fragment, characteristic of fractured clavicle, viz., in a direction downwards, forwards, and inwards, have occurred, then R. W. Smith believes that, however near the joint the fracture may appear to be, it must in reality have occurred externally to the costo-clavicular

ligament, which is too strong to admit of this displacement, or to be ruptured, and so to allow it to be occasioned.

Comminuted Fracture of the Clavicle is the result of severe and direct violence. It is a dangerous accident, as the subclavian vein and adjacent plexus of nerves, or the upper part of the pleura, may be seriously injured. In a case that was under my care, the subclavian vein was apparently wounded, great extravasation of blood taking place about the shoulder and neck, and the circulation through the veins of the arm being so much interfered with as to threaten gangrene. The case, however, did perfectly well under the continuous application of evaporating lotions to the shoulder, and attention to the position of the arm. But in another case, gangrene of the arm took place, leading to amputation at the shoulder-joint. The patient died of pyæmia, and a fragment about one inch long separated from the posterior part of the clavicle was found lying upon, and compressing, the subclavian vein.

Dr. John Ogle relates a case of comminuted fracture of the clavicle from direct violence, in which the right internal jugular vein was lacerated by one of the fragments, there being great extravasation of blood.

Treatment of Simple Fracture of the Clavicle.—There are few fractures for the cure of which so great a variety of ingenious and complicated contrivances has been devised, as those of the clavicle, and there are few in which so much ingenuity has been displayed in vain; for, however perfect the apparatus may appear to be, it seldom answers the purpose intended, viz., to cure the fracture without deformity. I believe that more may be done with a little skill and patience by simple means, than by the most elaborate mechanical contrivances.

When the fracture occurs at the tip of the acromial end of the clavicle, there is little if any linear displacement of the broken bone; and a figure-of-8 bandage round the shoulders, and keeping the arm in a sling, will prevent the tendency to rotation of the shoulder forwards. When the bone is broken underneath the scapulo-clavicular ligaments, there is but little displacement, and the same treatment will suffice.

But when the fracture is situated towards the middle of the bone, or indeed at any point to the inside of these ligaments, then the management is more difficult; and there are three principal indications to be attended to in order to correct the triple displacement of the scapular fragment.

1. By making a fulcrum of a thick wedge-shaped cushion with its broad end upwards in the axilla, and then bringing the elbow closely to the side, the humerus is made to act as a lever and draw the shoulder and the scapular fragment outwards, thus correcting the displacement inwards. 2. By pressing the elbow well backwards, behind the lateral median line of the body, the tendency to rotation forwards of the shoulder is removed. 3. By elevating the shoulder, and taking off the weight of the arm by means of a short sling that passes well under the elbow, the displacement downwards is remedied. By these simple means the triple displacement of the outer fragment is corrected. But the great difficulty consists in keeping the fracture in a good position; and when it is oblique, this becomes almost impossible, so that a cure without nodular or angular deformity is very seldom obtained.

I used formerly to recommend that the fingers should be bandaged separately, the palm wadded, and the bandage carried up as high as the axillary pad. More extended experience leads me to doubt the expediency of all these directions, and I now content myself with simply bandaging the hand and fore-arm lightly and leaving the tips of the

fingers free, so that the conditions of the circulation through the limb can be watched. Care must be taken not to use the lever-like movement of the arm against the fulcrum of the axillary pad too forcibly, lest the axillary vein or plexus of nerves be compressed. Before applying the roller, the elbow must always be flexed: otherwise undue and dangerous constriction of the arm may occur. The pad should be firm, made of bed-tick stuffed with bran, six inches long, five broad, and three thick at its upper part; the sling must support the elbow, and the hand should be well raised across the chest. In the accompanying figure, the sling does not extend so far towards the elbow as it ought to. It is represented in this way, in order not to conceal the other parts of the apparatus (Fig. 158). The elbow must be kept to the side by a few turns of a roller, or by means of a padded belt.

Fig. 158.—Apparatus for Fractured Clavicle.

In children, in whom these fractures often occur, there is frequently a difficulty in keeping the bandages properly applied; in these circumstances the starched apparatus will be found very useful, care being taken to re-apply it as often as it becomes loose, lest deformity result. Fractured clavicles occurring in females, to whom any irregularity of union in this situation would be very annoying, are best treated by keeping the patient lying flat on her back in bed for the first two or three weeks. By this plan, which is as old as the days of Hippocrates, I have seen better results produced than by any other.

When *both* clavicles are broken, the patient should be kept in bed, and the shoulder fixed and drawn backwards by means of a figure-of-8 bandage. In the case already alluded to (p. 406), this could not be borne, owing to the simultaneous fracture of the ribs; but the patient nevertheless made a good recovery with little deformity.

In **Comminuted Fracture of the Clavicle**, it must always be remembered that the subclavian vein may be compressed or contused. It is, therefore, of importance to avoid all means that may interfere with the return of venous blood from the arm. Hence the bandaging of the fingers, hand, and fore-arm should be omitted, and the axillary pad laid aside. The limb should be drawn back, supported in a sling, and the patient kept recumbent until union has been attained.

In comminuted simple fracture of the clavicle with vertical depression of the central portion, Annandale has removed the displaced piece of bone.

Fractures of the Scapula.—1. **Fracture of the Body of the Scapula** is not very commonly met with; and when it occurs, being always the result of considerable direct violence, it is usually associated with serious injury to the subjacent ribs and trunk. The thick layer of muscles overlying this bone not only protects it, but limits displacement, and renders the detection of its fracture difficult. The fracture usually takes place across the bone, immediately below the spine; but occasionally it may be split longitudinally or starred.

The *Treatment* consists in placing the arm in a sling, the application of a body-bandage, and support of the part with a pad. But all Surgeons who have seen this accident are agreed as to the extreme difficulty

of obtaining union without considerable deformity; which, however, is of less moment here than in most other situations.

Fractures in the Vicinity of the Shoulder-Joint are of common occurrence, and may happen either in the bony points of the scapula that overhang this articulation, or else in the upper end of the humerus. Not unfrequently there is double fracture in the neighborhood of this articulation; thus the acromion may be broken, as well as the neck of the humerus. These complications, as well as, in many cases, the amount of contusion, and the rapid swelling that takes place, necessarily render the diagnosis somewhat difficult.

2. The **Acromion**, forming as it does the very tip of the shoulder, is more frequently broken than any other part of the scapula. But, in spite of its exposed situation, fracture of this process through its base is not very common; at least I have seen but few cases of it, and there is good reason to believe that many of the cases of supposed fracture in this situation are in reality cases of delayed ossification of the line of junction between the base and the epiphysis. Notwithstanding this source of fallacy, there can be no doubt, as is proved by numerous preparations, that this fracture does occur.

The *Signs* of this fracture are obvious. When the acromion is broken off near its root, the arm hangs as a dead weight by the side, and the patient, feeling as if his arm were dropping off, supports it with the other hand. There is flattening of the shoulder, which is most marked when the patient is looked at from behind; and the head of the humerus can be felt somewhat lower in the axilla than natural. On running the finger along the spine of the scapula, a sudden inequality in the line of the bone can be detected; and, on raising the elbow and rotating the arm, crepitus can be felt, the rounded outline of the shoulder being restored.

When the tip only of the acromion is broken off, the nature of the injury may be suspected if the patient be unable to raise his arm to a level with his head, so as to touch the crown, owing to some of the fibres of the deltoid having lost their points of attachment; and it may be determined by the existence in a minor degree of some of the preceding signs, which prevent the accident from being confounded with paralysis of the deltoid from contusion; and especially by the tip being felt to be detached. But, as has already been stated, this may be a congenital defect, to which perhaps attention has only been directed when the shoulder has been bruised or otherwise injured.

The *Treatment* consists principally in raising the elbow, so as to take off the weight of the limb, and to push up the acromion by the head of the humerus. If the extremity only be broken off in front of the acromio-clavicular articulation, a pad may be placed between the elbow and the side, in order to direct the arm somewhat upwards and inwards, and the limb must be fixed in this position by a bandage and sling. Should the fracture have taken place at or behind the line of the clavicular articulation, the treatment must be the same as that for fractured clavicle.

When the base of this process is broken across, there is not much separation between the fragments, and union usually takes place by bone. When the apex is detached, fibroid or ligamentous union generally occurs, the fragments being widely separated.

3. The **Coracoid Process** is but seldom broken, there not being more than ten or twelve unequivocal cases of this accident recorded. It cannot happen, except by very direct violence. There is in the Museum of University College a preparation showing a fracture of the base of this

process, implicating and extending through the glenoid cavity, and complicated with fracture across the base of the acromion. The attachment of such powerful muscles as the pectoralis minor, biceps, and coraco-brachialis, displaces the fragment considerably, and would do so still more, were it not that it is kept in position by the ligaments to which it gives insertion, and whose fibres are expanded over it.

The only *Treatment* that can be adopted is to put the arm in a sling and fix it to the side.

4. **Fracture of the Neck of the Scapula** immediately behind the glenoid cavity is a rare injury. Its existence has been doubted: A. Cooper and South have stated that cases so described are, in reality, instances of fracture of the upper end of the humerus. There is, according to South, no preparation in any museum in London illustrating fracture of the neck of the scapula. A case, however, recorded by Spence in the *Edinburgh Medical Journal* for 1863, puts the occasional occurrence of the injury beyond doubt. A man was brought into the Edinburgh Infirmary, who had fallen on his shoulder while intoxicated. There was falling of the limb towards the axilla, with projection of the acromion and flattening of the deltoid; and crepitus was felt. The contour of the shoulder was restored by drawing the arm from the side and raising the limb. The man died some days afterwards from meningitis, the result of an injury to the forehead which he had received during the fall. On examining the shoulder, "the fracture was found to pass obliquely from below, upwards and forwards, commencing about half-an-inch behind the origin of the long head of the triceps, and separating the neck and four-fifths of the lower part of the glenoid cavity from the scapula. The long head of the biceps and the whole of the glenoid ligament had also been torn from the upper fragment of the glenoid cavity, and carried along with the displaced portion."

The *Treatment* of such an injury, if it were diagnosed, would consist in keeping the whole arm well raised and fixed to the chest, with a pad in the axilla.

FRACTURES OF THE HUMERUS.—In studying the fractures of the humerus, we must divide that bone into three parts,—the Upper Articular End, the Shaft, and the Lower Articular End.

1. **Fractures of the Upper Articular End of the Humerus** not unfrequently occur, constituting an important class of injuries which have been carefully studied by Sir A. Cooper, and more recently by R. W. Smith, whose works on *Fractures* deserves the attentive perusal of every practitioner.

Five kinds of fracture of the humerus are met with in the immediate vicinity of the shoulder-joint. Two of these are *Intracapsular*, viz., Simple Fracture of the Anatomical Neck, and Impacted Fracture of this portion of the bone. The remaining three are *Extracapsular*, viz., Fractures of the Surgical Neck—Simple and Impacted; and Separation of the Great Tubercle.

Intracapsular Fracture of the Neck of the Humerus.—When the fracture occurs at the *anatomical neck*, the head of the bone is detached from the tubercles, a little above or at the line of insertion of the capsule. This fracture is occasioned by severe falls or blows on the shoulder. It cannot result from indirect violence. A fall on the hand or elbow may dislocate the humerus or fracture its shaft, but it cannot break its upper articular end. This fracture is comparatively rare in children, but is frequent in adults.

The signs of this injury are by no means very distinct, though much

light has been thrown upon them by the labors of R. W. Smith. There is loss of motion in the shoulder, with some swelling and considerable pain, together with some deformity; an irregularity, produced by the upper end of the lower fragment, can be felt towards the inner side of the joint; crepitus is easily produced; and there is, on measurement from the acromion to the olecranon, shortening to the extent of about one-third of an inch.

When this fracture is *impacted*, the upper fragment penetrates the lower one. In consequence of this, the axis of the humerus is directed somewhat inwards towards the coracoid process; here also some irregular osseous swelling may be detected. The head of the bone can be felt in the glenoid cavity, but is not in the axis of the limb, the elbow projecting slightly from the side, there being at the same time a hollow some little distance under the acromion. There is consequently more deformity about the joint in the impacted than in the simple intracapsular fracture, with the same impairment of motion, but only slight crepitus on firmly grasping the shoulder and rotating the elbow.

In fracture of the anatomical neck of the humerus, the portion of bone broken off is truly a foreign body in the joint, and, being unconnected with any ligamentous structure, may perish, and thus give rise to destruction of the articulation. When this does not take place, it is probable that impaction of the fragment has occurred, and that thus its life is maintained; or it may happen, as R. W. Smith supposes, that its vitality is occasionally preserved in consequence of some partial union being kept up between it and the rest of the bone by untorn shreds of capsule. In either case, the principal reparative efforts are made by the lower fragment, which deposits callus abundantly.

Treatment.—As there is often much swelling from contusion in these cases, evaporating lotions should be had recourse to for a few days. A pad may then be placed in the axilla, and a leather or gutta-percha cap fitted to the shoulder and upper arm, the limb having previously been bandaged. The hand must be supported in a sling, and the elbow fixed to the side. In examining and reducing these intracapsular fractures, no violence should be employed, lest the impaction of the fragment be disturbed, or portions of untorn capsule, on which the ultimate osseous repair of the injury is dependent, be broken through.

Extracapsular Fracture of the Neck of the Humerus.—In this injury, the bone is broken through the *surgical neck*, or that portion which is below the tubercles, but above the insertions of the pectoralis major, latissimus dorsi, teres major, and deltoid muscles. This accident is most frequent in adults, but it may occur in children as well, the separation taking place through the line of junction between the epiphysis and the shaft of the bone. In this fracture there is double displacement; the head of the bone and upper fragment are rotated outwards and abducted by the muscles inserted into the great tubercle, whilst the shaft is drawn upwards and inwards and forwards under the coracoid process, by the muscles going from the trunk to the arm, and by the flexors of the limb.

The *Signs* of this fracture are sufficiently obvious. The glenoid cavity is filled by the head of the bone, which can be felt in it. Below this there is a depression; crepitus is easily produced, and there are great mobility of the lower fragment, and shortening of the limb to the extent of from three-quarters to an inch; but the most remarkable sign is the prominence formed by the upper end of the shaft of the humerus, which projects under the integuments, and can readily be felt under the coracoid

process, especially when the elbow is pushed upwards and rotated. The axis of the bone is also directed obliquely upwards and inwards towards this point. In consequence of the irritation of the nerves of the axillary plexus by this fragment, which is often very sharp and angular, a good deal of pain is complained of in the arm and fingers. This sign, however, is not met with in children, owing to the greater smoothness of the fractured surfaces.

Impacted Extracapsular Fracture of the Neck of the Humerus has been especially treated by R. W. Smith in his excellent work on *Fractures*. In this injury, the superior fragment being penetrated by the inferior one, the continuity of the bone and its firmness are in a great measure preserved; hence, the usual signs of fracture, such as mobility, displacement, and crepitus, are not readily obtainable, and indeed the signs of this injury are chiefly negative. Thus, there are impairment of motion, slight deformity about the joint and upper part of the arm, and some crepitus; but the latter is only obtainable with difficulty, and by firmly grasping the head of the bone whilst the elbow is being rotated.

The *Treatment* to be adopted in these cases should be carried out in accordance with the following principles and details: 1. To bandage the fingers, hand, and arm so as to prevent congestion and œdema of the limb; 2. To place a pad in the axilla to act as a fulcrum; 3. To bandage the elbow closely to the side so as to overcome the displacement inwards of the upper end of the shaft, which will be thrown outwards by the axillary pad; 4. To carry the elbow (whilst it is being bandaged to the side) forwards across the chest, in advance of the lateral median line, in order to counteract the forward displacement of the upper end of the shaft, and thus to throw it backwards towards the head of the humerus; 5. To apply a sling so as merely to support the hand and wrist, allowing the elbow to hang unsupported, and thus letting the weight of the arm counteract the displacement upwards (Fig. 159). By these means the triple displacement of the upper end of the lower portion of the shaft inwards, forwards, and upwards will be counteracted. The whole is then to be steadied by means of a leather or gutta-percha cap, carefully moulded and fitted to the shoulder and arm. As the brushing and extravasation are often very considerable in these cases, it is as well to apply evaporating lotions in the first instance.

Fig. 159.—Apparatus for Fracture of the neck of the Humerus.

In the management of some of these fractures, I have found a very convenient apparatus in a leather splint about two feet long by six inches broad, bent upon itself in the middle, so that one-half of it may be applied lengthwise to the chest, and the other half to the inside of the injured arm; the angle formed by the bend, which should be somewhat obtuse, being well pressed up into the axilla. In this way the limb is steadied, and the tendency to displacement inwards of the lower fragment is corrected.

In some cases, fracture of the neck of the humerus is followed by atrophy of the bone, though good union has taken place.

Compound Fracture of the Surgical Neck of the Humerus is not of common occurrence I have had a case under my care in which the accident happened to a lad from a fall out of a window. The fracture was transverse, and the upper extremity of the lower fragment was driven upwards, and protruded through the deltoid, to the extent of an inch and a half. It was reduced with difficulty: as great irritation was set up around the seat of injury, and as there was a tendency to recurrent protrusion of the upper extremity of the lower fragment, this was turned out by enlarging the wound, and about an inch and a half of it sawn off. Union took place between the fragments, and recovery was effected with a very useful arm.

Separation of the Great Tubercle of the Humerus occasionally occurs from falls and blows upon the shoulder; but more commonly as the result of the violent action of the three external rotator muscles which are inserted into it. In this injury there is a double displacement; the tubercle is carried upwards and outwards away from the head of the bone, and under and external to the acromion process; the head is drawn upwards and inwards by the muscles passing from the trunk to the arm, as well as by the flexors of the arm, in such a way that it lies upon the inner edge of the glenoid cavity under the coracoid process, and is indeed almost luxated. The consequence of this double displacement is a great increase in the breadth of the shoulder, which has nearly double its natural size; on examination, a rounded tumor—the head of the bone—movable on rotating the arm, can be felt under the coracoid process, whilst another osseous mass—the great tubercle—may be felt at the outer and back part of the joint; between these a sulcus is perceptible, and crepitus may be felt by bringing the two portions of bone into apposition and rotating the arm. This accident, which is rare, has been most carefully described by Guthrie and Smith, to whom we are indebted for our knowledge of its pathology.

The *Treatment* consists in an attempt to bring the detached tubercle into contact with the head of the bone, and retain it there; this may be done either by mechanical means, or by relaxation of the muscles. The treatment by mechanical means consists in placing a pad in the axilla, and bringing the elbow to the side so as to throw out the head of the bone, at the same time that, by means of a compress, the tubercle is pressed into proper position, the arm being supported in a sling. The treatment by relaxation of the muscles consists in elevating and extending the arm from the trunk; in carrying this out, it is necessary that the patient be confined to bed, the arm being supported on a pillow.

Compound and Comminuted Fractures of the Head of the Humerus can only occur as a consequence of gun-shot injury. In these cases there may also be splintering of the acromion or coracoid processes, of the neck of the scapula or glenoid cavity, and possibly injury to the axillary vessels and plexus of nerves.

The *Treatment* must depend upon the extent of the complications. If the injury be chiefly confined to the head of the humerus, with little damage to the soft parts, and none to the main vessels or nerves, excision should be practised, any splinters in connection with the scapular processes being removed at the same time. Should, however, the soft parts be extensively disorganised, and especially the great vessels and nerves torn, amputation is the sole resource.

2. **Fractures of the Shaft of the Humerus** are usually somewhat oblique from above, downwards and outwards. They may occur from any kind of external violence, but are more frequently the result

of muscular action than those of any other long bone. The nature of the accident can be at once detected by the great mobility of the fragments, the ready production of crepitus, and the other ordinary signs of fracture. The direction of the displacement depends upon the seat of the fracture. If the bone be broken above the insertion of the deltoid, and below those of the pectoralis major, latissimus dorsi, and teres major muscles, the lower fragment will lie to the outer side of the upper, and will be drawn upwards while the lower end of the upper fragment will be drawn inwards. If the fracture be below the insertion of the deltoid, the upper fragment will be abducted by that muscle, and the lower will be to its inner side.

The *Treatment* is of the simplest character; flexing the elbow and applying two or three well-padded splints, the inner one of which should be rectangular, being all that is necessary. In these cases the elbow must be well supported, contrary to what is done in fractures of the surgical neck. For if, in fractures of the shaft, the elbow and whole of the fore-arm be not well supported in a sling or trough, their weight may drag down the lower fragment, cause elongation of the limb, and thus lead to separation between and disunion of the fragments. In many cases an angular outer splint carried from the acromion to the hand is the best apparatus that can be employed. In applying a splint to the inner side of the arm, care must be taken that it do not press upon the axillary vein, lest œdema of the limb occur.

3. **Fractures in the Vicinity of the Elbow-joint** may occur through any of the osseous prominences in this situation. They are very commonly complicated with dislocation, with severe contusion and injury of the joint, or perhaps with comminution of the bones, and considerable laceration of the soft parts covering them. In most cases swelling speedily comes on, tending to obscure materially the nature of the injury. They may be classified as—Separation of the Lower Epiphysis of the Humerus; Transverse Fracture of the Lower End of the Bone; Fracture of either Condyle; and to these may be added Fracture of the Olecranon.

Separation of the Lower Epiphysis of the Humerus before its ossification with the shaft is complete, is a frequent accident in children; the fragment being carried backwards, with the bones of the fore-arm connected with it, so as to cause considerable displacement posteriorly. In this accident the trochlea, the capitellum, and the condyles, are broken off from the shaft, which remains *in situ*. It is the detached articular end of the bone that is carried backwards with the fore-arm by the action of the triceps muscle. The detached fragment may readily be replaced; but, as soon as it is left to itself, it again slips out of its position. As this happens without crepitus, owing to the fracture being between cartilaginous surfaces, the injury is apt to be mistaken for dislocation of the fore arm backwards.

Transverse Fracture of the Lower End of the Humerus, just above the condyles, occasionally occurs in adults. The displacement backwards of the fore-arm and lower fragment, the pain, and crepitus, indicate the nature of the accident.

Fracture of either Condyle of the Humerus may arise from blows and falls on the elbow. There is considerable pain about the seat of the injury, but usually not much displacement; unless, as in Fig. 160, there be a transverse fracture of both condyles, constituting what may be termed the T-shaped fracture of the lower epiphysis of the humerus. Crepitus, however, may readily be felt by rotating the radius, if it be the

external condyle that is injured; or by flexing and pronating the fore-arm, if it be the internal condyle that has been detached.

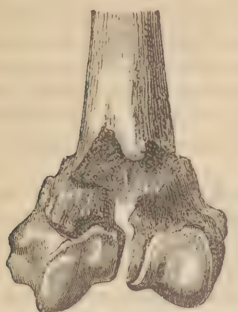


Fig. 160.—T-shaped Fracture of Lower Epiphysis of Humerus.

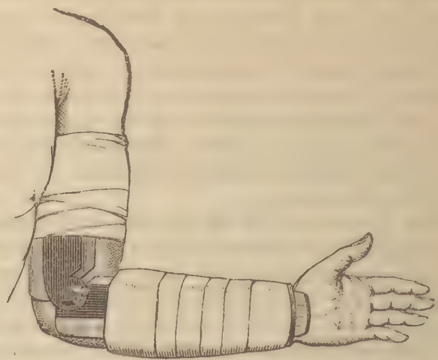


Fig. 161.—Angular Splint applied to inside of Arm.

The *Treatment* of all these injuries must be conducted on very similar principles. The swelling and inflammatory action, which rapidly supervene, usually require local antiphlogistic treatment, and the application of cold lotions, or of irrigation; the arm being flexed, and supported in an easy position on a proper splint. After the subsidence of the swelling, the fractured bone, whatever be the precise nature of the injury, is best maintained in position by being put in an angular splint applied to the inner side of the limb (Fig. 161); the fore-arm being kept in the mid-state between pronation and supination, and well supported in a sling. It is in these particular fractures that passive motion should be had recourse to early, a tendency to rigidity of the joint being otherwise often left. The motion should be begun in adults at the expiration of a month or five weeks; in children, at the end of three weeks after the occurrence of the accident. Union usually takes place readily. I have, however, seen one instance of an ununited fracture of the external condyle of the humerus in a boy about ten years old.

Injury of Nerves in Fracture of the Humerus.—In simple fracture of the shaft of the humerus, it may happen that the trunk of the musculo-spiral nerve, where it winds round the bone in a flat groove, may be so seriously damaged, either by the fracture itself or in the subsequent formation of callus, as to occasion its paralysis. So also when the fracture is lower down, and the external condyle is broken off, the posterior interosseous branch of that nerve may be injured. When the main trunk is paralysed, supination is imperfect, and extension of the hand and fingers is entirely lost; the fore-arm becomes pronated, and the hand and fingers passively flaccid, so that a peculiar form of *wrist-drop* ensues; all the muscles supplied by the musculo-spiral nerve becoming paralysed. Some degree of supination, however, can be done by the action of the biceps. Although the extensors of the wrist and fingers

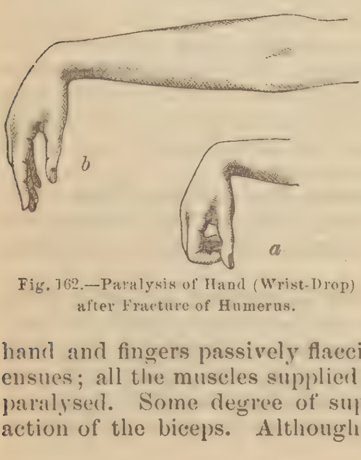


Fig. 162.—Paralysis of Hand (Wrist-Drop) after Fracture of Humerus.

have become paralysed, yet, when the fingers are flexed into the palm (Fig. 162 *a*), they can be extended rapidly, and with some degree of force, from the second phalangeal articulation, as far as is represented in Fig. 162 *b*. This limited movement of extension is due to the action of the interossei and lumbricales muscles, which, being supplied by the ulnar and median nerves, do not participate in the paralysis that affects all the long extensors of the fingers M. Duchenne de Boulogne maintains that the interossei muscles extend the second and third phalanges and flex the first phalanx, the extensor communis acting only on the first phalanx.

When the posterior interosseous nerve only is paralysed, the loss of supination and extension is necessarily not so complete as when the whole trunk is affected; these movements being still practicable to a limited extent, through the medium of the long supinator and the long extensor of the wrist, which are supplied by the radial branch. If the paralysis of the extensors and supinators be allowed to continue for some time, the fore-arm and hand become draw into a state of permanent flexion and pronation, by secondary or so-called pathological shortening of the muscles that act in those directions (Fig. 163).

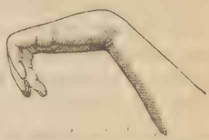


Fig. 163.—Permanent Flexure from Paralysis after Fracture of Humerus.

The *Treatment* of this complication of simple fracture of the humerus must be conducted on the following principles: 1. The support of the wrist, hand, and fingers in a hand and arm splint, so as to prevent the tonic contraction of the flexors; 2. Placing the limb in the mid-state between pronation and supination; and 3. The application of electricity (faradisation) to the affected muscles. In order to overcome the flexion of the hand and fingers, the splint (Fig. 164) may be employed with advantage, the hand-piece admitting of upward movement, so as to raise the hand and extend the fingers forcibly.

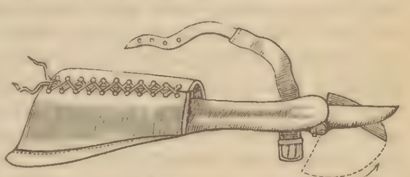


Fig. 164.—Apparatus for Wrist-Drop after Fracture of the Humerus.

In a case in which the symptoms denoted pressure on the musculo-spiral nerve by one of the fragments or by the callus, Ollier of Lyons cut down on the bone, removed a portion of the callus by chisel and mallet, so as to expose the nerve, and excised also a portion of bone (apparently of the lower fragment), which was strangulating the nerve. Gradual improvement took place; and, at the end of six and a half months, the patient had regained considerable power of extension of the carpus.

Compound and Comminuted Fractures of the Elbow Joint are necessarily serious accidents. They are commonly occasioned by falls on the point of the olecranon, which is the process of bone most frequently and extensively fractured. In some cases the olecranon escapes injury, whilst the lower epiphysis of the humerus is splintered into many pieces; and more commonly, perhaps, both bones, ulna as well as humerus, are injured. As the integuments over the point of the elbow are thick and hard, very extensive comminution of the bones may occur with very little apparent injury of the soft parts. When these fractures are the result of gun-shot injury, the soft parts may be extensively torn, and the bones greatly shattered. In the cases that occur in civil practice, I have seldom seen much laceration of the soft parts.

The *Treatment* of these important accidents must necessarily depend upon the amount of injury done both to bones and to soft parts. If the articulation be simply opened with little laceration of the surrounding soft parts, and no comminution of the fractured bone, the limb may very commonly be saved by antiseptic and active antiphlogistic treatment. If the bones be much shattered, the soft parts not being seriously implicated, removal of the splinters and resection of the injured joint will enable the Surgeon to save the rest of the limb. But if the soft parts be extensively contused and torn, as well as the bones comminuted, amputation of the arm may be required. If recourse be not had to primary resection, abscess may form in front of or around the joint, with much constitutional disturbance, requiring the removal of the articular osseous extremities in a few weeks, or possibly amputation of the limb. When resection is determined on, either as a primary or as a secondary operation, the question may arise whether a partial or a complete removal of the articulation should be practised. In these cases, I am decidedly in favor of complete resection; any articular surface that is left covered with an incrusting cartilage, interferes very materially with the deposition of lymph necessary for repair. Before this can take place, the cartilage must be removed by a process of distintegration, or necrosis of a tedious character, and attended by profuse suppuration. All this is avoided by the complete resection of all the articular surfaces, even where one only is injured. When primary resection is determined on, the sooner the operation is done the better; when a secondary operation is performed, the Surgeon must wait until suppuration is fairly established, and then he should do it with as little delay as possible, lest hectic or pyæmia supervene. The operative procedure necessary for the complete resection of a compound and comminuted fracture of the bones that enter into the conformation of the elbow-joint, differs in no material respect from the same operation for disease of the articulation, which will be described in Chapter XLIX.

Fractures of the Fore-arm.—1. The only fracture of the bones of the fore-arm that commonly occurs *in the vicinity of the elbow-joint*, is that of the **Olecranon**; this almost invariably happens from falls upon the elbow, and hence is usually accompanied by very considerable bruising and swelling of the parts. It may possibly, though very rarely, occur from muscular action. The displacement is usually considerable, the detached fragment being drawn upwards by the triceps muscle. Occasionally, however, when the ligamentous expansion of the tendon of this muscle is not torn through, there is but little separation of the fragments. In the majority of cases, as the injury takes place from direct violence, there is much swelling about the joint; and not unfrequently the fracture is comminuted or compound.

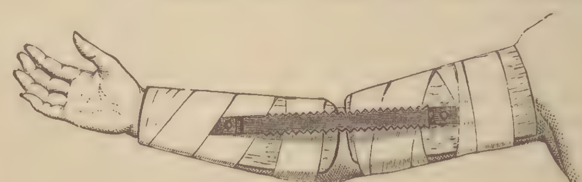


Fig. 165.—Apparatus for Fractured Olecranon.

The *Treatment* is best conducted by moderately straightening the arm, and maintaining it in that position by means of a well-padded light

wooden splint laid along its fore part. But, although the arm should be kept nearly straight, it should not be quite extended. The best and most easy position in which to put it up is that into which the arm naturally falls when extended; in this there will be seen to be slight flexion at the elbow (Fig. 165). If the fore-arm be too rigidly extended on the arm, it may be carried backwards beyond the straight line, owing to the loss of the resistance of the olecranon against the fossa at the back of the humerus.

In **Compound Fracture of the Olecranon**, when an attempt is made to save the joint, and where there is the possibility of ankylosis, the semi-flexed would be preferable to the straight position. In such cases, the antiseptic method should be used. If this fail, excision of the joint may be required.

Fracture of the Coronoid Process of the Ulna has been supposed by many Surgeons to be a common complication, and, indeed, a cause of dislocation of the ulna backwards. There is every reason, however, to believe that this is an error, and that, in point of fact, it is one of the rarest accidents of surgery—at least, we must come to this conclusion, if we are to judge by the small number of recorded cases or of preserved specimens of this injury. Hamilton states that there are but eight cases on record in which the symptoms led to a belief that this accident had occurred; that in none of these cases were the symptoms unequivocal, but in all open to doubt; and that in not one case did dissection afford an opportunity of positively demonstrating this fracture. There are but four preparations in existence, according to Hamilton, illustrative of this injury, and all these, he says, are doubtful. In the cases in which this accident has been supposed to have occurred, the injury has arisen from falls on the palm of the hand, by which the ulna has been driven backwards, and the coronoid process, striking against the lower end of the humerus, splintered off. In a case related by Liston, the injury is said to have been produced by muscular action in a boy, who, hanging for a length of time by his hands from a high wall, fell to the ground, and was supposed to have met with this fracture. Whether the fracture actually occurred is doubtful; and, if it did, it is still more doubtful whether it was occasioned by the contraction of the brachialis anticus muscle, or by the violence of the fall.

In the present uncertain state of our knowledge, I forbear to speak of the supposed symptoms of this accident. If it were suspected, the proper treatment would consist in placing the limb in angular splints.

2. **Fractures of the Middle of the Fore-arm** are of very common occurrence, both bones being usually broken, with much shortening, angular displacement, and crepitus. Occasionally one bone only is fractured, from the application of direct violence. When this is the case, more attention will be required in establishing the precise nature of the injury.

The *Treatment* is simple; a splint somewhat broader than the arm should be placed on each side of it, and a narrow pad laid along the interosseous space, in order that the patency of this may be preserved; no bandage should be placed under the splint. If masses of callus happen to be thrown out across the interosseous space, pronation and supination of the hand will be lost, and the utility of the limb greatly impaired.

Compound Fractures of the Fore-arm seldom give much trouble or require amputation, but they very commonly lead to obliteration of the interosseous space, and thus impair the utility of the limb, by preventing pronation and supination.

3. **Fractures of the Lower Extremity of the Radius,** near the wrist, are very frequent. Their importance, not only from a diagnostic point of view, but also in reference to treatment, has caused them to be carefully studied; and their nature and pathology have been specially investigated by Colles, Goyrand, Voillermier, Nélaton, R. W. Smith, and Gordon.

The lower end of the radius is liable to several different kinds of fracture. The more common of these is that which is generally called "**Colles' Fracture,**" from the eminent Surgeon who first fully described it. In this fracture the carpal end of the radius is broken across, usually by a fall on the palm of the hand, the lower fragment being displaced backwards. Dr. Gordon, who has bestowed great attention on the mechanism and treatment of this fracture, states that, in twenty-seven old specimens examined by him, the line of fracture posteriorly varied from $\frac{3}{8}$ to $1\frac{3}{4}$ inch, and anteriorly from $\frac{3}{8}$ of an inch to two inches above the carpal border of the radius, being in ten of the cases one inch and under, in ten more than one inch but not over $1\frac{3}{4}$ inch, in the others undefinable. The fracture is usually oblique from before backwards. Besides Colles', other fractures are met with in this situation. They are of three kinds: 1, Simple Transverse; 2, with Comminution of the Lower Fragment; and 3, with firm Impaction of the Upper into the Lower Fragment.

The *Signs* of fracture of the lower end of the radius vary greatly, according to their nature. When *simple*, there is usually no very great displacement; but there will be noticed some tumefaction about the wrist, a swelling at its dorsal aspect, loss of the movement of the radius, and crepitus on rotating the bone whilst the hand is drawn down. When the fracture is *comminuted* and still more so when *impacted*, the signs

Fig. 166.—Fracture of Lower End of Radius; Side View.

are very marked and characteristic; so much so, that they may always be looked upon as diagnostic of these forms of this accident. The deformity thus occasioned gives rise to a remarkable undular distortion of the wrist. On looking sideways at the hand and fore-arm which are held midway between supination and pronation, it will be seen that there is a considerable dorsal prominence apparently situated just above the back of the carpus (Fig. 166); immediately underneath this, on the palmar aspect of the wrist, just opposite the annular ligament, there is a remarkable hollow or arch, confined to the radial side of the arm; a little above this, that is to say, on the lower part of the anterior aspect of the fore-arm, there is another rounded prominence, not nearly so large or distinct, however, as the one on the dorsal aspect. The hand is abducted and rotated outwards, so that its axis is oblique to that of the fore-arm; the ulnar border being somewhat convex, and the

Fig 167.—Fracture of Lower End of Radius: Back View.

styloid process of the ulna projecting sharply under the skin (Fig. 167). The radial side of the wrist is, on the contrary, somewhat concave, appearing to be shortened.

The pain at the seat of injury is very severe, and is greatly increased by moving the hand, especially by making any attempt at supination. The hand is perfectly useless, the patient being unable to support it. All power of rotating the radius is lost, the patient moving the whole of the arm from the shoulder at once, and thus apparently, but not really, pronating and supinating it. Crepitus can readily be felt when the fracture is simple or comminuted; but when it is impacted, the most careful examination fails to elicit it.

The Cause of the particular Deformity that is observed, and indeed the general pathology of the injury, has been the subject of much discussion; in a great measure owing, I believe, to the rarity of the opportunities of dissecting recent fractures of this kind. Surgeons are, however, now agreed that the dorsal prominence is due to the lower fragment, carrying the carpus with it, being displaced backwards and upwards; whilst the palmar tumefaction is due to the projection forwards of the lower end of the upper fragment, which is thrown into a state of forcible pronation. There is thus a double cause of displacement in operation. The displacement of the upper fragment is evidently due to the pronatores quadratus and radii teres; but to what is the displacement of the lower fragment due? Is it to the peculiar manner in which the two fragments are locked into one another? or is it due to muscular action? Some years ago I had an opportunity of dissecting and carefully examining the state of the limb in a woman who died of paralysis in University College Hospital, twelve days after meeting with this accident. On examining the left arm, which presented all the signs of this injury in a marked degree, and from which Fig. 168 was taken, a transverse fracture of the radius was found about an inch above its articular surface. The lower fragment was split into three portions, between which the upper fragment was so firmly impacted to the depth of more than half an inch, as to require some force in its removal. The three portions into which the lower fragment was split were of very unequal size; the two posterior ones being small, consisting merely of scales of bone; the third fragment, the largest, comprising the whole of the articular surface of the radius, which was somewhat tilted upwards and backwards, carrying the hand with it. To this fragment were attached the supinator longus, and part of the pronator quadratus; the ligaments and capsule of the joint were uninjured.

Fig. 168.—Fracture of Lower End of Radius: Displacement of Articular Surface.

Fig. 169.—Fracture of Lower End of Radius: Displacement of Lower Fragment.

This case presented the appearance usually met with in this kind of injury; the lower fragment being displaced in such a way that its articular surface looked slightly upwards, backwards, and somewhat outwards, so as to be twisted as it were upon its axis. The upper fragment was

found in a state of pronation, and was driven into and firmly impacted in the lower one.

That the deformity in this case was the result of impaction, there could be no doubt; and that impaction is the cause of deformity in many cases, is proved by an examination of several specimens of consolidated fracture of the radius preserved in the different collections in London, and by the difficulty of accounting in any other way for the occasional impossibility of properly reducing these fractures. The great traction that is usually required to remove the deformity, and the absence of distinct crepitus until after forcible traction has been employed, indicate the existence of this impaction.

Mechanism.—The mode in which the accident occurs, and the position of the hand at the moment of its coming into contact with the ground, will, I think, materially influence the kind of fracture that occurs as well as the consequent amount and character of the resulting deformity. When a person falls on his hands outstretched to save him, the limb is usually not completely pronated. It is half-way between complete pronation and the mid-state between pronation and supination. Complete pronation is a forcible muscular effort which is not carried to the full extent at the moment of danger. The hand is in fact three-quarters pronated—not wholly so. The effect of this position is, that the ulnar border is slightly directed downwards and first comes into contact with the ground, and the fracturing force is directed in a line that is somewhat outwards, or towards the radial side, as well as backwards and upwards. Hence the hand is driven from the ulna towards the radius, causing the strongly marked projection of the styloid process of the ulna; and, the radius being broken across at its lower end, the fragment carrying with it the carpus and hand is driven backwards, upwards, and slightly outwards, causing the double deformity of a projection at the back of the fore-arm immediately above the carpus, and the concavity along the outer line of the radius.

But if, as sometimes happens, the hand be completely and forcibly pronated at the moment when it touches the ground, then the shock, which is principally received on the ball of the thumb and the radial side of the wrist, is not directed immediately upwards in the axis of the radius; but the force impinges in a direction obliquely from before backwards, and from without inwards, as well as from below upwards, and thus has a tendency, as soon as the bone is broken, to rotate the lower fragment on its own axis, and to tilt the articular surface somewhat upwards and outwards. As the upper fragment descends, its posterior surface of compact tissue is forced into the cancellous structure of the lower fragment to such a depth as will admit of the two posterior portions of compact tissue coming into contact; and thus the upper line of compact tissue is driven into the lower fragment, to an extent corresponding to the degree with which the fragment is rotated upwards and backwards. If the bone be brittle, or the force be continued after this amount of impaction has taken place, the lower fragment will be splintered.

The prominence of the styloid process of the ulna in these cases is the result of the shortening of the radial side of the wrist and hand, consequent upon the impaction.

When the fracture is simple, or when it is comminuted without impaction, I agree with R. W. Smith that the displacement of the lower fragment is the result of muscular action alone. This I have had an opportunity of observing in the following case. A man, 64 years of

age, fell to the ground from a height of twenty-five feet. In his fall he broke the left radius just above the wrist, but also met with such serious injuries of the pelvis and abdomen, that he died in an hour after admission into the Hospital. On carefully dissecting the arm about twenty-four hours after death, I found that the radius was fractured transversely about half an inch above its lower articular end, and that the lower fragment was completely comminuted. The wrist, which presented all the signs of this fracture in a very marked, but not an extreme degree, could not be restored to its normal shape by any amount of traction that I could employ. On exposing the muscles of the limb, it was found that the supinator longus was attached to the lower, and the pronator quadratus to the upper fragment; the latter muscle being slightly lacerated at its lower part. The upper fragment was strongly pronated. The chief cause of displacement, and the main obstacle to reduction, was found to exist in the two radial extensors of the wrist, the tendons of which were excessively tense; next to these, the special extensors of the thumb presented most tension, and then the supinator longus, which was far less tense than either of the other sets of muscles, but especially than the radial extensors, the tendons of which were strongly defined. On dividing these tendons, and on pressing the lower end of the upper fragment outwards, reduction was easily effected. Here the displacement was evidently due to two causes The upper fragment was forcibly pronated by the action of its special pronators; and the hand, with the lower fragment attached, was drawn upwards and backwards by and in the direct line of the radial extensors of the wrist. There was no impaction nor interlocking of fragments, but perfect mobility, and hence muscular action was enabled to come into play.

In another case which I have since dissected, the muscles chiefly at fault were the radial extensors; next to these the extensors of the thumb; the supinator longus being but slightly if at all contracted.

Besides this injury, R. W. Smith has described a fracture of the lower end of the radius in consequence of falls upon the back of the hand, in which the inferior fragment is displaced forwards. In these cases the character of the deformity indicates the nature of the injury. It can readily be reduced, with a feeling of crepitation, by traction.

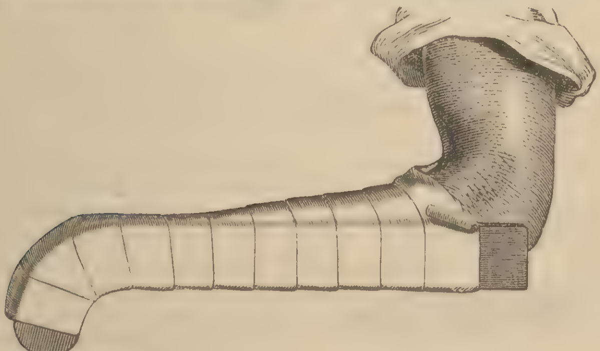


Fig. 170.—Old Pistol-Splint for Treatment of Fracture of the Lower End of the Radius.

In another variety of fracture in this situation, the lower end of the radius and that of the ulna are broken off, resembling very closely dislocation of the wrist backwards. But the existence of grating, the ready reduction of the swelling, and the attachment of the styloid processes

of the radius and of the ulna to the carpus, with which they move, will be sufficient to establish the diagnosis.

The *Treatment* of the ordinary fracture of the radius near the wrist is best conducted by the apparatus (Figs. 170, 171). This consists of a pistol-shaped wooden splint, which is placed along the outside of the arm, reaching from the elbow to the extremity of the fingers. Forcible extension and counter-extension should be practised, with the view of disentangling the fragments, and removing the dorsal prominence. The splint should be carefully padded, the padding being made thicker opposite the lower fragment, and then, with the straight portion held vertically, the head of the splint should be fixed to the back of the hand. Gentle extension should then be made, and the hand bent to the ulnar side by raising the straight portion of the splint to the horizontal position, so as to make it lie against the back of the fore-arm, and held there, while another straight splint, extending from the elbow to the lower end of the upper fragment, is placed on the inner side of the fore-arm. Both splints should then be fixed by means of a roller, care being taken to have the inner splint well padded along the radial border, so as to counteract the tendency to pronation of this part of the bone. The arm must then be placed in a sling. The pistol-splint should be worn for a fortnight or three weeks. At the end of this time a gauntlet of gutta-percha, or other plastic material, may be moulded to the wrist and worn instead of the splint. All apparatus should be discontinued at the end of five weeks in the adult, one week earlier in children. When the fracture is impacted, little if any alteration in the deformity can be produced. When it is mobile, it may usually be brought into good position. The fracture unites in the course of a month or five weeks. After the first few days it is well, especially in elderly people, to leave the fingers free, and to encourage movement in them, lest that painful stiffness result which is so common a sequela of the accident. Passive motion of the joint may, however, often be commenced earlier than the union of the fracture, with great advantage to the patient, more particularly when the fracture is impacted. It is often fully three months before the stiffness of the hand and wrist is

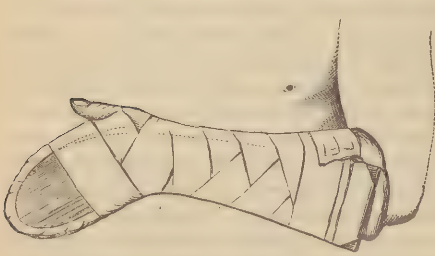


Fig. 171.—Pistol-Splint shaped to hand.

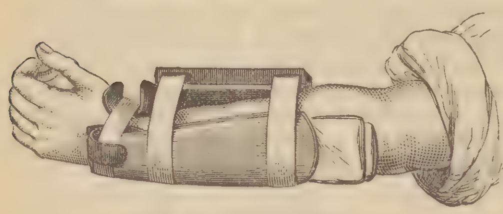


Fig. 172.—Gordon's Splint.

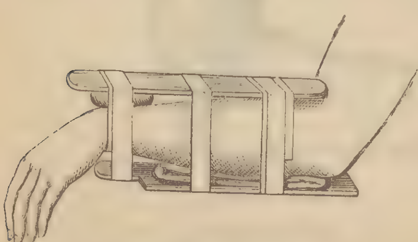


Fig. 173.—Nélaton's Apparatus.

so far diminished, even by the use of friction and douches, as to enable the patient to use the fingers, the stiffness of the wrist being often due to the extension of a fissure into the joint. It sometimes happens that in both arms the radius is broken at the same time in this situation, constituting a somewhat serious condition, inasmuch as the patient is not able to feed or assist himself in any way during the treatment.

The accompanying Figs. 172 and 173, represent two forms of splints that have justly many advocates, viz., Gordon's and Nélaton's. I have, however, obtained such excellent results from the use of the "pistol" splint, that I have not found it necessary to adopt any other plan of treatment.

Fractures of the Metacarpus and Fingers are of so simple a character in every way as scarcely to call for detailed remarks. In the *Treatment*, rest of the part upon a leather, gutta-percha, or pasteboard splint is all that is requisite. In compound fracture of these bones, every effort should be made to save the part; if removal become necessary, it should be to as limited an extent as possible (p. 92).

FRACTURES OF THE PELVIS AND THE LOWER EXTREMITY.

Fractures of the Pelvis.—The danger here depends not so much on the extent of the fracture as on its complication with internal injury, and on the degree of violence with which it has been inflicted. Fracture may extend in any direction across the pelvic bones, though most commonly it passes through the rami of the os pubis and ischium, and across the body of the ilium, near the sacro-iliac articulation. In some cases the symphysis is broken through, and in others the fracture extends across the body of the pubic bone.

It occasionally happens that a portion of the crest of the ilium is broken off; but this is of little consequence, even though the bone continue depressed. When the rami of the os pubis and ischium, or the whole body of the ilium, are broken through, there is, of course, considerable danger of internal injury. If the patient escape this, the fracture, however extensive it may be, may unite favorably. A patient, under my care at the Hospital, had a fracture extending through the rami of the pubes and ischium in front, and across the ilium behind, in a line parallel with and close to the sacro-iliac symphysis, so as completely to detach one-half of the pelvis; he recovered, however, without any bad consequences occurring.

The nature of the injury is usually apparent from the great degree of direct violence that has been inflicted upon the part; from the pain that the patient experiences in moving or in coughing; from the impossibility to stand, in consequence of a feeling as if the body were falling to pieces when he attempts to do so; and from the ready mobility of the part and crepitus on seizing the brim of the pelvis on each side, and moving it to and fro, or on rotating the thigh of the affected side. In examining a patient with suspected fracture of the pelvis, care should, however, be taken not to push the investigation too closely, lest injury be inflicted by the movement of the fragments. In those cases, indeed, in which the fracture does not extend completely across the pelvis, or in which it is seated in the deeper parts of the ischium, an exact diagnosis may be impossible.

In fractured pelvis, the principal sources of danger arise from injury to the bladder and urethra, with consequent extravasation of urine; from laceration of the rectum, or fracture of the acetabulum; and in examin-

ing the pelvis no rough handling should be allowed, lest injury to the pelvic organs be inflicted by the fragments.

In the *Treatment*, the first thing to be done is to pass a catheter into the bladder, in order to ascertain the condition of the urinary apparatus; if it be injured, recourse must be had to measures that will be described in speaking of laceration of the urethra. The next thing is to keep the part perfectly quiet, so as to bring about union. With this view, a padded belt, or a broad flannel roller, should be tightly applied around the pelvis, the patient lying on a hard mattress. The knees may then be tied together, and a leather or gutta-percha splint put upon the hip of the side affected, so as to keep the joint quiet, and to prevent all displacement of the fragment. If the urethra have been lacerated, it must be borne in mind that, however completely the patient may recover from the fracture, he will most certainly become the subject eventually of the most troublesome and intractable form of urethral stricture—the traumatic.

Fracture of the Acetabulum is an accident that can only occur as the result of very great violence directly applied to the hip. It may take place in two situations; either through the floor of the cavity, or only through the rim, a portion of which is detached. It is probably occasioned in most instances by the head of the thigh-bone being driven forcibly against the surface of the acetabulum. Hence, when the rim is broken, it is usually the posterior part that is detached, and the head of the femur slips out upon the dorsum ilii.

Fracture through the floor of the acetabulum is usually complicated with extensive comminution of the pelvic bones and serious internal injury, so as to be followed by death. In the University College Museum is a preparation of a fracture of the acetabulum, with comminution of its floor and of the ilium. Sanson and Sir A. Cooper have seen the bone resolved into its three primitive fragments; and in some cases the comminution has been so great that the head of the femur has been thrust into the pelvic cavity.

In such extensive and grave injuries as these, the Surgeon can do little more than support the pelvis with a padded belt, and place the limb on the long splint.

When a portion of the rim of the acetabulum is detached, as the result of direct violence, the head of the femur will slip out upon the dorsum ilii, or into the sciatic notch, and the signs of ilio-sciatic dislocation manifest themselves. In a case of this kind, which was under my care at the Hospital in a muscular man aged about thirty, the shortening and inversion of the limb and displacement of the head of the bone into the sciatic notch, were all well marked. Traction readily effected reduction, with distinct crepitus; but, as soon as extension was discontinued, the head of the bone slipped back into the sciatic notch.

The diagnosis in this case was made, and in similar instances may readily be effected, by attention to three circumstances:—the dislocation, its ready reduction with crepitus, and its immediate return when the limb is left to itself.

The *Treatment* consists in the application of the long splint with a broad padded belt, so as to secure steadiness of the head of the bone. But with every care a return of displacement will readily take place, and an unsatisfactory result can scarcely be avoided; shortening of the limb, and consequent lameness, being almost inevitable.

Fractures of the Sacrum are excessively rare, except as the result of gun-shot injury. When occurring from other causes, such as falls, they are almost invariably associated with fracture of the pelvic bones,

and then they have always been fatal. The records of surgery contain but a very few observations, probably not more than six or eight, of uncomplicated fracture of the sacrum arising from other causes than gun-shot. I have had two cases of fracture of the sacrum under my care. Both had a rapidly fatal issue. In one there was also fracture through the pubic bone; in the other, the sacrum was the only bone injured. In it, the fracture was the result of a blow on the lower part of the back by the buffer of a railway carriage. The preparation is in the University College Museum. The only other preparation with which I am acquainted, is one in the Museum of the College of Surgeons. These fractures are almost invariably transverse, with displacement forwards of the upper margin of the lower fragment. This was the case in both the instances under my care; but Richerand has published a case in which this bone was split vertically in consequence of a fall on the face; and its crucial and multiple fracture has been described by others. The injury can necessarily only arise from direct violence of a severe character, and is attended by much extravasation and pain, together with neuralgia along the course of the posterior sacral nerves, which may be implicated in or irritated by the fracture. The *Treatment* would consist in the application of a padded pelvic band.

The Coccyx, though more exposed, is seldom broken. But fracture of it may occur from falls backwards, or from direct blows on the part, the tip being bent forcibly forwards, and the elements of the bones separated. The pain in these cases is excessively severe, owing to the bruising of the ligamentous and tendinous expansions that cover the bone. It is greatly increased in sitting and walking, and in defecation. It is sometimes removed on reducing the fractured and displaced fragments by pressure through the rectum, but may continue for months, and even longer, constituting a truly neuralgic affection of the part. South relates the case of a gentleman who broke his coccyx by sitting on the edge of a snuff-box, and who suffered such severe pain that he was obliged to wear a pad on each tuberosity of the ischium, in order that the coccyx might be in a kind of pit, and free from all pressure when he sat.

Under the term **Coccydynia**, Sir J. Y. Simpson has described a painful affection of the coccyx and its neighboring structures, which chiefly occurs in women, commonly as the result of injury, and is often very severe and persistent, so as to prevent the patient from sitting, or even walking with comfort. It is an affection that closely resembles in its symptoms the pain occasioned by fissure and ulcer of the anus and rectum. It usually arises from a blow on the part, though it appears sometimes to originate independently of any external violence. The *Treatment* recommended by Sir J. Y. Simpson consists in the free subcutaneous division, by means of a tenotome, of the muscular and tendinous structures connected with the coccyx. The section of these structures is made first on one side, then on the other, and finally around the tip, so as completely to isolate the bone. The good effects of the operation are usually immediate, the pain ceasing at once.

Fractures of the Thigh-Bone are of great practical interest, from their frequency and severity. They may occur in the Upper Articular End of the bone, in its Shaft, or in its Lower End. In these different situations, every possible variety of fracture is often met with.

1. **Fractures of the Pelvic End of the Bone** may be divided into those that occur *through the Neck Within the Capsule* of the joint,

those that occur *Outside the Capsule*, and those that implicate the *Trochanters* alone.

Intracapsular Fracture of the Neck of the Thigh-Bone may be either simple, the bone being merely broken across; or impacted, the lower portion of bone being driven into the upper fragment.

This intracapsular fracture may almost be looked upon as a special injury of advanced life, being but seldom met with in persons under fifty. Thus Sir A. Cooper states that, of 251 cases with which he met in the course of his practice, only two were in persons below this age. It may, however, happen at an early period of life: Stanley has recorded the case of a lad of eighteen, who met with this injury, and Hamilton has described it as occurring in a girl aged sixteen and in a man aged twenty-five. A remarkable circumstance in connection with this accident is, that it commonly happens from very slight degrees of violence, indeed almost spontaneously. Thus, the jarring of the foot in missing a step in going downstairs, catching the toes under the carpet, tripping upon a stone, or entangling the foot in turning in bed, are sufficient to occasion it. **It is especially in women that this injury is met with.**

Cause.—The occurrence of this fracture in old age is owing indirectly to the changes in structure, shape, and position of the head and neck of the femur with advancing years. The cancellous structure of these parts becomes expanded, the cells large, loose, and loaded with fluid fat. The compact structure becomes thinned, and proportionately weakened, especially about the middle and under part of the neck, which, appearing to yield to the weight of the body, is shortened; and, instead of being oblique in its direction, becomes horizontal, inserted nearly at a right angle into the shaft. In consequence of these changes in structure and position, it becomes less able to bear any sudden shock by which the weight of the body is thrown upon it, and snaps under the influence of very slight degrees of violence. When it breaks, the capsule may remain uninjured, but the prolongation of it which invests the neck of the bone is usually torn through. In some cases, however, this cervical reflection is not ruptured, the lower portion of it especially often remaining for some length of time untorn, at last, however, giving way under the influence of the movements of the limb, or by being softened by local inflammatory action. As the violence occasioning the fracture is generally but slight, and as the vascularity of this portion of the bone is trifling in old people, there is but little extravasation of blood.

The fragments are almost always so separated that the fractured surfaces are not in apposition: the upper end of the lower fragment is drawn above and to the outer side of the head of the bone, and at the same time is twisted so that its broken surface looks forwards. The head remains in the acetabulum, attached by the ligamentum teres, and sometimes preserving a connection with the lower fragment, through the medium of some untorn portions of the fibrous membrane investing the neck. R. W. Smith has observed, that in some instances the two fragments become interlocked or dovetailed as it were into one another, in consequence of the line of fracture being irregular and dentated.

Signs.—These are, alteration in the shape of the hip, crepitus and pain at the seat of injury, and inability to move the limb, with shortening and eversion of it. These we must consider separately, as important modifications of each are sometimes noticed.

The **Alteration in the Shape of the Hip** is evidenced by some flattening of the part, the trochanter not being so prominent as usual. This process is also approximated to the anterior superior spine of the

ilium; and, on rotating the limb, it is felt to move to and fro under the hand, not describing the segment of a circle so distinctly as on the sound side. The circle described by the trochanter on the injured side is much smaller than that on the sound side. In the sound limb, the trochanter describes the segment of a circle having a radius equal to the length of the head and neck of the bone. On the injured side, the circle has a radius equal only to the length of that portion of the neck that still remains attached to the shaft of the bone. During this examination *crepitus* will usually be felt, though this occasionally is very indistinct and even absent, more especially if the limb be not well drawn down at the time it is rotated, so as to bring the fractured surfaces into apposition; and much *pain* is produced by any movement of, or pressure upon, the joint.

The **Attitude of the Limb** is so peculiar, as in general to indicate at once to the Surgeon what has happened. There is a striking appearance of helplessness about it. As the patient is lying on his back in bed, it is everted; shortened somewhat, with the knee semi-flexed; on requesting him to lift it up, he makes ineffectual attempts to do so, and at last ends by raising it with the toe of the opposite foot, or with his hands. When he is taken out of bed and placed upright, the injured limb hangs uselessly, with the toes pointing downwards, and the heel raised and pointing to the inner ankle of the sound side, the patient being unable to rest upon it (Fig. 174). In some cases, however, after the fracture has occurred, the patient can lift the limb somewhat, but with much exertion, from the couch on which he is lying; or can even manage to walk a few paces, or to stand for a few minutes upon it, with much pain and difficulty. This is owing either to the cervical reflection of the capsule being untorn, or else to the fragments not being separated, having become locked into one other; and it usually occurs in those cases in which the other and more characteristic signs of this fracture are not well marked.

Fig. 174.—Attitude of Limb in Intracapsular Fracture of the Neck of the Thigh-Bone.

Eversion of the limb is almost an invariable accompaniment of this fracture. It is most marked in those cases in which the shortening is most considerable. This eversion has usually been attributed to the action of the external rotator muscles, which are inserted into the upper end of the lower fragment. But I cannot consider this as the only, or indeed the principal cause of this position; for, not only is it very difficult to understand how these muscles can rotate outwards the limb after their centre of motion has been destroyed by the fracture of the neck of the femur, their action being rather in a direction backwards than rotatory under these circumstances; but we find that the limb falls into an everted position in those cases in which, the fracture being in the shaft, and altogether below the insertions of these muscles, no influence can be exercised by them on the lower fragment. I look upon eversion in cases of fractured thigh as not being a result of muscular action at all, but simply the natural attitude into which the limb falls when left to itself. Even in the sound state, eversion takes place spontaneously whenever muscular action is relaxed, as

during sleep, in paralysis, or in the dead body; and in the injured limb, in which there is, as it were, a suspension of muscular action, it will occur equally. Indeed, the shortening that takes place will specially tend to relax the external rotators, and thus still more prevent their influencing the position of the limb.

Inversion of the foot in cases of intracapsular fracture has been sometimes noticed. I have seen two instances; Smith, Stanley, and other Surgeons, have also recorded cases. This deviation from the usual symptoms of this injury has been attributed by some to the cervical ligament not having been torn through at its inner side, but that, as Stanley observes, while it may prevent eversion, cannot occasion inversion; by others to the fact of the lower fragment in these cases being always found in front of the upper one. This circumstance, which is much insisted on by R. W. Smith, appears to me to be rather the result than the cause of the inversion; for any traction inwards of the lower fragment by the adductor muscles of the thigh would have a tendency to draw the upper end of this fragment to the anterior, or in other words, the inner side of the upper one. I am rather disposed to think that this inversion is owing, in some cases at least, to the external rotators being paralysed by the violence they receive from the injury that occasions the fracture and that thus the adductors, acting without antagonists, draw the thigh and with it the leg inwards. In both instances that fell under my observation, and in some of those that have been published, the fracture resulted from severe direct injury to the hip, and was not occasioned by the patient jarring his foot, or by any indirect violence operating at the end of the limb.

The **Shortening** in cases of fracture within the capsule seldom exceeds, in the first instance, from half an inch to an inch, depending on the extent of the separation between the fragments; it cannot, indeed, in the early periods of the fracture, very well exceed the width of the neck of the bone, as the capsule is usually not torn through. After the fracture has existed some time, the capsule of the joint may yield, allowing greater separation between the fragments, and then it may amount to two, or even two and a half inches. It not uncommonly happens that the shortening, which is at first but very slight, about half an inch, suddenly increases to an inch or more; this is accounted for on the supposition of the cervical ligament, which had at first not been completely ruptured, at last giving way entirely; or it may be owing to the fragments which were originally interlocked becoming separated. It is in those cases in which there is but slight separation of the fragments, and consequently little shortening, that the other signs of fracture are not very strongly marked, and that the patient preserves some power over the movements of the limb.

The **Constitutional Disturbance** in intracapsular fracture of the neck of the femur in old people, though trifling at first, often eventually becomes considerable; and the injury frequently terminates fatally, from the supervention of congestive pneumonia, an asthenic state of system, or sloughing of the nates from confinement to bed during treatment. Hence this injury must always be considered as very dangerous, and not unfrequently fatal.

Mode of Union.—The treatment of these fractures turns in a great measure upon the view that is taken of their mode of union, and on the constitutional condition of the patient. In some cases no union occurs, but the head of the bone remains in the acetabulum, being hollowed into a smooth, hard, cup-shaped cavity, in which the neck, which has become rounded off and polished, is received, and plays as in a socket.

The union of the intracapsular fracture of the neck of the femur takes place, however, in the great majority of cases by fibrous tissue. This is owing to two causes; in the first place, to the circumstance (which I look upon as the most important) that the fractured surfaces are not in apposition with one another; and secondly, that the vascular supply sent to the head of the bone, consisting only of the blood that finds its way through the vessels of the ligamentum teres, is insufficient for the proper production of callus.

In some cases, however, bony union takes place. This can only happen, when, in consequence of the cervical ligament being untorn, or the fracture being impacted, the surfaces are kept in some degree of apposition, and the vascular supply to the head of the bone is speedily augmented by the blood carried into it through the medium of the plastic matter that is deposited between the fragments. In no other circumstance is it probable that osseous union takes place in these fractures; hence the infrequency of its occurrence, there being in all probability not more than eighteen or twenty cases on record as having thus terminated in this country. When bony union does take place, the head of the femur will usually be found to be somewhat twisted round in such a way that it looks towards the lesser trochanter, owing to the eversion that has taken place in the lower fragment.

Treatment.—As these fractures do not unite by bone, unless the fragments be in good contact, it is useless to confine the patient to bed for any long period, if the signs, especially the amount of *shortening*, indicate considerable separation between the fragments, or if the patient be very aged and feeble. In these circumstances, lengthened confinement to bed most commonly proves fatal by the depressing influence which it exercises on the general health, by the intercurrence of visceral disease, or by the supervention of bed-sores. It is therefore a good plan to keep the patient in bed merely for two or three weeks, until the limb has become somewhat less painful, the knee being well supported upon pillows. After this time, a leather splint should be fitted to the hip, and the patient be allowed to get up upon crutches. There will be lameness during the remainder of life; but, with the aid of a stick and properly adjusted splint, but little inconvenience will be suffered.

When the fragments do not appear to be much separated, there being but little shortening and indistinct crepitus, and more particularly if the patient be not very aged, and in other respects sound and well, an attempt may be made to procure osseous union. This may be done by the application of the long thigh-splint; or, if this cannot very readily be borne, by the double inclined plane, with a padded belt strapped round the hips. This apparatus should be kept applied for at least two or three months, when a leather splint may be put on and the patient move about upon crutches. During the whole of the treatment, a generous, and even stimulating diet should be ordered, and the patient kept on a water-bed or cushion. In these fractures of the neck of the femur, the starched bandage will often be found to be most useful. It may be applied as in fractured thigh, but should have additional strength in the spica part, and indeed may be provided with a small pasteboard cap so as to give more efficient support. In old people, this plan of treatment is especially advantageous, as it enables them to sit up or even to walk about, and thus prevents all the ill effects of long confinement in bed.

Extracapsular Fracture of the Neck of the Thigh-Bone is commonly met with at an earlier period of life than the injury which has just been described, being most frequent between the ages of thirty and

forty, but it is also met with at advanced periods of life. It is the result of the application of great and direct violence upon the hip, and occurs equally in both sexes.

This fracture may be of two kinds; the *simple*, or the *impacted*. In both cases the neck of the bone is commonly broken at, or immediately outside, the insertion of the capsule of the joint. The fracture is almost invariably comminuted; indeed, I have never seen a case in which the great trochanter was not either detached or splintered into several fragments. In many instances the lesser trochanter is detached, and the upper end of the shaft injured (Fig. 175). This splintering of the trochanter is owing to the same violence that breaks the bone, forcing the lower end of the neck into the cancellous structure of this process, and thus, by a wedge-like action, breaking it into fragments. When the neck continues locked in between these, we have the impacted form of fracture.

Fig. 175.—Simple Extracapsular Fracture of the Neck of the Thigh-Bone: Detachment of the Trochanter.

The *Signs* of extracapsular fracture vary according as it is simple or impacted; but in both cases they partake of the general character of those of fracture within the capsule. The individual signs, however, present certain well-marked differences.

The hip will usually be found much *bruised and swollen* from extravasation of blood, which is often considerable.

In the **simple fracture**, the *crepitus* is very distinct and loud, being readily felt on laying the hand upon the trochanter, and moving the limb. The separate fragments into which the trochanter is splintered may occasionally be felt to be loose. The *pain* is very severe, and greatly increased by any attempt at moving the joint, which to the patient is impossible.

The *eversion* is usually strongly marked, and the position of the limb is characteristic of complete want of power in it. *Inversion* occurs more frequently in this fracture than in that within the capsule. Smith finds that of 7 cases of inversion of the limb in fractures of the neck of the femur, 5 occurred in the extracapsular fracture; and of 15 cases of intracapsular fracture, this condition was met with in 3. When there is much comminution of the trochanter, the foot will commonly remain in any position in which it is placed, but generally has a tendency to rotate outwards.

The *shortening* of the limb is very considerable, being never less than from an inch and a quarter to two inches and a half, or three inches.

The **Impacted Extracapsular Fracture** of the neck of the thigh-bone occurs when, in consequence of a heavy fall on the hip, the neck is broken across at its root, and the upper fragment is driven into the cancellous structure of the lower one, often splitting up and detaching the trochanter (Figs. 176, 177).

The *Signs* of this form of fracture are often somewhat negative, rendering its diagnosis and detection extremely difficult. There is *pain* about the hip, with *eversion* of the foot, sometimes slight, sometimes great, and some shortening, occasionally not more than a quarter of an inch, usually amounting to about half an inch, but never exceeding one inch. There is but little *crepitus*—in some cases none can be detected, owing to the close interlocking of the fragments; and the patient can

then raise the foot for a few inches off the couch on which it is laid, and even walk a short distance upon it with hobbling motion, though with much pain. Some flattening over the trochanter is usually perceptible: sometimes an increase in breadth from before backwards In consequence of the impaction the limb cannot be restored by traction to its proper length, and hence incurable lameness always results from this injury.

Figs. 176, 177.—Section of Impacted Extracapsular Fractures of Neck of Femur; showing the degree of Impaction and of Splintering in different cases.

In the extracapsular fracture of the neck of the femur, death not uncommonly results from the severity of the injury, the pain and irritation of the fracture, and the consequent shock to the system. The great extravasation of blood into the tissues of the limb has been known to be sufficient to account for the fatal result. When the patient lives, bony union takes place, large irregular stalactitic masses being commonly thrown out by the inferior fragment, so as to overlap the several splinters of bone and thus give the appearance of great thickening and projection of the trochanter. This callus is most abundant posteriorly in the intertrochanteric space (Fig. 179).

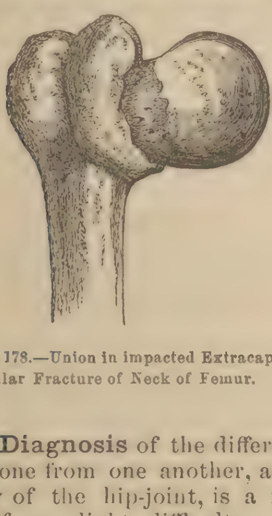


Fig. 178.—Union in impacted Extracapsular Fracture of Neck of Femur.

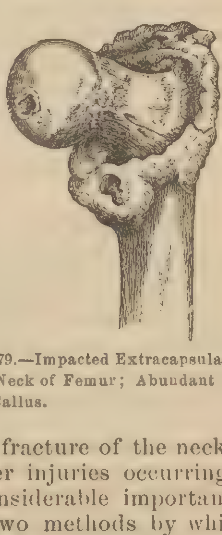


Fig. 179.—Impacted Extracapsular Fracture of Neck of Femur; Abundant Formation of Callus.

The **Diagnosis** of the different forms of fracture of the neck of the thigh-bone from one another, and from other injuries occurring in the vicinity of the hip-joint, is a matter of considerable importance, and often of no slight difficulty. There are two methods by which the exact position of the trochanter major may be accurately determined,

and which consequently are of greater diagnostic value in injuries, whether fractures or dislocations, of the hip. The first is by Nélaton's line; the second, by Bryant's ilio-femoral triangle.

Nélaton's Diagnostic line (Fig. 180, dark line) consists of a line drawn from the anterior superior spine of the ilium to the tuber ischii. If the trochanter be at its proper level, this line ought to touch its upper border. The importance of this line is, that when the head of the femur is in its normal situation, it touches the summit of the trochanter in every position of the limb. If the trochanter be displaced in any direction, a corresponding change in its relation to this line will ensue.

Fig. 180.—Nélaton's Line—dark. Bryant's Ilio-femoral Triangle—dotted.

Bryant's Ilio-femoral triangle (Fig. 180, dotted line) is formed by placing the patient in the recumbent position; then, drawing a line from the anterior superior spine of (?) the ilium perpendicularly downwards, another line also from the anterior superior spine obliquely to the summit of the trochanter, and a third, or the base line, horizontally backwards from this to the perpendicular line, a triangle will thus be formed. The oblique line corresponds to the first part of Nélaton's line (Fig. 180), and may be taken, just as Nélaton's, as the diagnostic line for di·locations of the head of the femur backwards; whilst Bryant's base line is the test-line for all cases in which the head of the femur is shortened, or the head of the bone thrown upwards.

Between the *intracapsular* and the ordinary *extracapsular fractures* there can be no difficulty in diagnosis; all the signs of the latter being much more strongly marked than those of the former injury, as may be seen by the annexed Table, the difference of age and the degree of violence required to break the bone being also important elements in the diagnosis.

Diagnosis between Intra- and Extra-capsular Fracture of the Neck of the Thigh-bone.

Intracapsular.	*Extracapsular.*
1. Cause generally slight and indirect, such as catching the foot in the carpet or slipping off the curb-stone.	1. Cause usually severe and direct violence, such as falling from a height or a blow on the hip.
2. Force usually applied longitudinally or obliquely.	2. Force usually applied transversely.
3. Age, rarely below fifty; most commonly in feeble aged persons.	3. Age, usually below fifty; chiefly in vigorous adults.
4. Pain and constitutional disturbance slight.	4. Pain and constitutional disturbance usually considerable.
5. No apparent injury to soft parts about hip.	5. Considerable extravasation, ecchymosis, and signs of direct injury to hip.
6. Crepitus often obscure.	6. Crepitus (when not impacted) very readily felt.
7. Shortening usually at first not more than one inch.	7. Shortening (when not impacted) at least two inches or more.

It is more difficult to distinguish between the *intracapsular fracture* and the *impacted extracapsular fracture.* In the former case, however, the crepitus and eversion are more marked, and the injury usually occurs from less direct violence than when the fracture is outside the capsule. In the latter case, also, traction cannot restore the limb to its proper length as in the former instance.

Severe contusions of the hip are sometimes followed by eversion of the limb with inability to move it, so that at first sight it might be supposed that the bone was broken. In these cases, however, the absence of immediate shortening and crepitus will always establish the diagnosis. But though no immediate and sudden shortening can occur without fracture, these contusions may be followed at a remote period by shortening of the limb from atrophic changes in the head and neck of the femur. When the injured hip-joint has been the seat of *chronic rheumatic arthritis*, and the limb is already somewhat shortened before the accident, the difficulty of diagnosis becomes great; here, however, the history of the case, and the fact of the shortening not being of recent occurrence, will be sufficient to establish the nature of the injury. The diagnosis of these injuries from *dislocations* will be considered in a subsequent chapter.

The *Treatment* of the extracapsular fracture may very conveniently and efficiently be conducted by means of the long splint, a padded belt, if necessary, being strapped firmly round the hips underneath it; or the plan recommended by Sir A. Cooper, of placing the patient on a double inclined plane, with both feet and ankles tied together, and a broad belt, well-padded, firmly strapped round the body, so as to press the fragments of the trochanter firmly against one another, will be found an excellent mode of keeping the limb of a proper length, and the fragments in contact.

Occasionally the fracture extends *through the trochanter major and upper part of the shaft* without implicating the neck of the bone. Here there is shortening to about three-fourths of an inch, or an inch, with much eversion, and crepitus readily felt. This fracture, which unites firmly and well by bone, must be treated in the same way as the last.

Compound Fractures of the Neck of the Thigh-bone can only occur from bullet-wounds. In these cases the choice lies between amputation at the hip-joint, resection of the injured portion of bone, or treating the case as an ordinary compound fracture. The choice of the Surgeon, for reasons stated at p. 247, lies between the latter two alternatives, which are the only ones that afford a reasonable hope of safety to the patient.

Fracture of the Trochanter Major, by which this process is broken off from the rest of the bone, is described by Astley Cooper, Aston Key, and Nélaton as being always the result of direct violence. It may be simple or comminuted. The fragment is usually drawn upwards and backwards, rarely forwards; and more rarely it remains fixed by fibrous bands in its normal place. The symptoms are, separation between the fragments; and crepitus which is most readily obtained by flexing and abducting the thigh and rotating it outwards, at the same time that the fragments are firmly pressed together. There is no shortening of the limb. The exact nature of the injury is often concealed by the swelling from extravasated blood. The fracture is very rare without accompanying fracture of the neck.

2. **Fractures of the Shaft of the Thigh-bone** are of very common occurrence; every possible variety of the injury being met with

here. They are usually oblique, except in children, when they are commonly transverse, and are often comminuted, double, or compound.

The *Signs* are well marked. There is shortening, usually to a considerable extent, with eversion of the limb, crepitus readily produced, and much swelling from the approximation of the attachments of the muscles. The lower fragment is always drawn upwards and to the inner or outer side of the upper one, and rotated outwards; and when the fracture is high up there is a great tendency to angular deformity, in consequence of the projection forwards of the lower end of the upper fragment. In all cases there is this forward projection, and in most an outward displacement or abduction as well of the upper fragment. But in some instances, though more rarely, it is drawn inwards as well as forwards.

I have taken three opportunities of ascertaining by dissection the condition of parts that leads to the projection forwards and lateral displacement of the lower end of the upper fragment in fracture of the femur. The first case was that of an old man who died about three hours after meeting with a compound comminuted fracture of the middle and lower thirds of the right thigh-bone, and in whom eversion of the upper fragment was very distinctly marked. It was found that the gluteus maximus and medius could be divided without affecting the position of the bone; but when the gluteus minimus was cut across, it yielded somewhat. The pyriformis and external rotators are now felt to be excessively tense; and, on cutting these across, the end of the fragment could at once be drawn inwards, all opposition ceasing. The projection forwards still remained, however; and this, which was evidently due to the tension of the psoas and iliacus muscles, yielded at once on dividing them. It would thus appear that there must be a double displacement of the upper fragment; outwards, depending on the action of the external rotators; and forwards, owing to the contraction of the psoas and iliacus muscles.

The second case was one of displacement forwards and inwards. It was that of an elderly man, who died of internal injuries about half an hour after meeting with fracture of both thigh-bones, at the junction of the upper and middle thirds by the passage of a cart-wheel across the thighs and body. In this case nearly the same conditions were presented in both limbs. On the left side there was an oblique fracture, with shortening to the extent of about two inches; the upper fragment was tilted forwards and rather inwards, the lower one being drawn up behind it to the extent indicated. On dividing the psoas and iliacus, the upper fragment could be depressed slightly. The adductor brevis and pectineus were now seen to be tense; on cutting them through, it could be still further depressed. It was now drawn strongly inwards, in consequence of the extreme tension of the internal rotator muscles; on cutting them through, the fragment yielded completely. Part of the adductor magnus and of the adductor longus was torn. The other muscles were uninjured. When extension was made with the limb straight out, the flexors of the leg offered a slight resistance: they were divided. The vastus externus was next cut through; the lower fragment could then be drawn down a quarter of an inch; on dividing the vastus internus and crureus, it yielded one inch more; on cutting through the adductor magnus and longus, it came down three-quarters of an inch more; thus making up the two inches of shortening. On the right side, the fracture was the same as that in the other limb. The effect of the section of the different

muscles was the same; but the vastus externus seemed to take a somewhat larger share in the displacement of the lower fragment.

The *Treatment* of fractures of the shaft of the thigh-bone may be conducted in six different ways, each of which presents advantages in particular cases; hence an exclusive plan of treatment should not be followed.

Whatever treatment is adopted, and however carefully it may be carried out, the Surgeon must not be disappointed if, in the adult, a certain amount of shortening be left. This is more particularly the case where the fracture is oblique and high up: the more transverse and the nearer the condyles. on the other hand, the less will be the liability to shortening. In children, union may almost always be procured without any shortening of the bone. But a slight diminution in the length of the limb is in reality of no consequence, and gives rise to no inequality of gait; the pelvis, by the obliquity it assumes, remedying this. It is only when the shortening exceeds half or three-quarters of an inch, that it is important and occasions deformity.

1. The fracture may be treated by simply relaxing the muscles of the limb. This is effected by laying it upon its outer side, flexing the thigh well upon the abdomen and the leg upon the thigh, and supporting the limb in this position by an angular wooden or leather splint, extending from the hip to the knee or outer ankle, and by a short inside thigh-splint. This position I have occasionally adopted in fractures about a couple of inches below the trochanters, in which there is a great tendency to the projection outwards of the lower end of the upper fragment, and have found these cases turn out better in this way than by any other plan of treatment.

2. Extension, without regard to muscular relaxation, by means of Liston's or Desault's long splint and perineal band (Fig. 181), will be found a most successful plan of treating fractures in the middle and lower parts of the thigh.

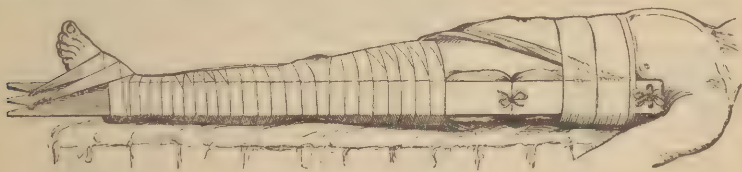


Fig. 181.—Liston's Long Splint.

In employing the long splint for the treatment of these fractures, care must be taken that it be of sufficient length to extend about six inches below the sole, and nearly as high as the axilla. The perineal band should consist of a soft handkerchief covered with oiled silk, and must be gradually tightened. If the perineal band occasion excoriation or undue pressure, so as to necessitate its removal, I have found advantage from keeping up extension with a heavy weight attached to the lower end of the splint. A very ingenious appliance has been contrived by my late House-Surgeon, Mr. G. Buckstone Browne, for employing elastic extensions from the foot. It consists of a brass catch, such as are used for the strings of window-blinds, attached to a vulcanized rubber ring, which is connected with a transverse piece of wood fixed to the leg by adhesive straps (Fig. 182). By means of this contrivance, elastic traction can be kept up to any degree required, without the danger of galling the skin of the instep.

In cases of compound fracture, where the aperture exists in the posterior and outer part of the limb, I have found a long thigh-splint, made

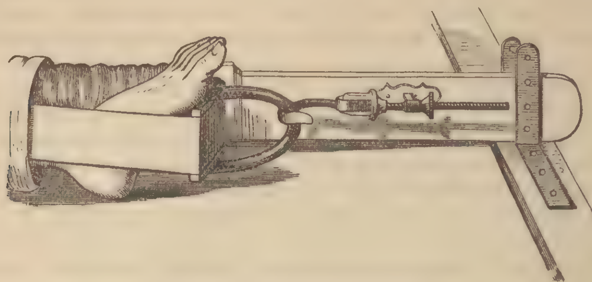


Fig. 182.—Browne's Elastic Catch.

of oak and bracketed opposite the seat of injury, the most convenient apparatus, enabling the limb to be kept of a proper length, and the wound to be dressed at the same time (Fig. 183).

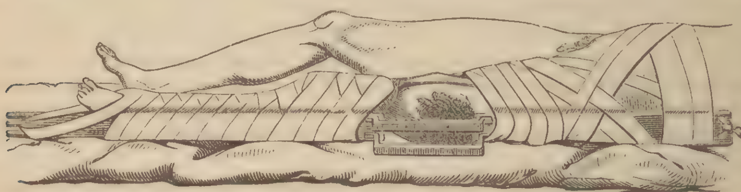


Fig. 183.—Compound Fracture of Shaft of Thigh-bone: Treatment by Bracketed Long Splint.

3. The double-inclined plane is especially useful in many compound fractures of the thigh, often admitting greater facilities for dressing the wound and the general management of the case, than any other apparatus that can be applied.

4. Extension of the limb by the attachment of a weight to the foot, a plan of treatment employed by James, of Exeter, and perfected by Buck,

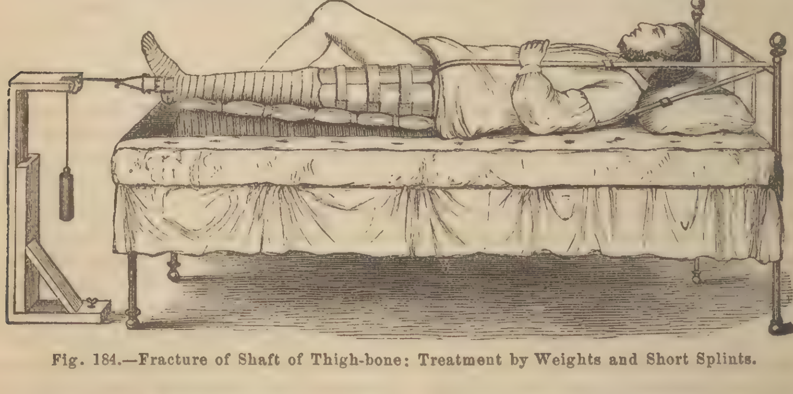


Fig. 184.—Fracture of Shaft of Thigh-bone: Treatment by Weights and Short Splints.

of New York, is a most simple and efficient means of treatment. The accompanying drawing (Fig. 184) illustrates this well. The weight re-

quired for extension should vary in the adult from five to ten pounds. The counter-extending means consist of a perineal band, which should be of India-rubber tubing properly covered with muslin and fastened to the head of the bedstead by means of straps.

5. Suspension of the limb from a splint applied along the anterior aspect, as in Fig. 185, has been recommended by N. R. Smith, of Balti-

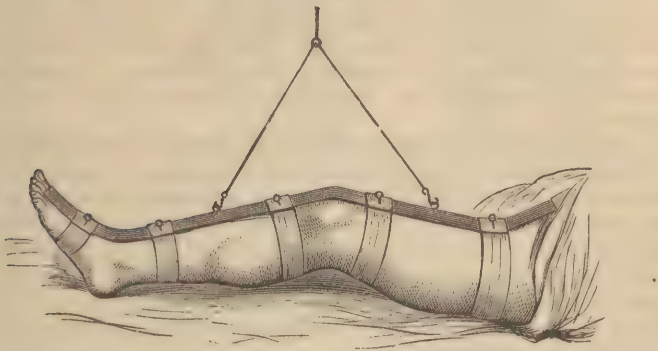


Fig. 185.—Limb suspended from Splint by Slings, preparatory to application of Roller.

more. As a general plan of treatment, it is not likely to be found advantageous. But it is easy to understand that, in certain cases, where injury was done to the soft parts of the limb posteriorly, it might be found very useful.

6. The starched or plaster bandage may be employed in most cases. In treating fractures of the shaft of the thigh-bone with the starched bandage, the following plan will be found convenient. The limb should be evenly and thickly enveloped in a layer of cotton wadding; a long piece of strong pasteboard, about four inches wide, soaked in starch, must next be applied to the posterior part of the limb, from the nates to the heel. If the patient be very muscular, and the thigh large, this must be strengthened, especially at its upper part, by having slips of bandage pasted upon it. Two narrower slips of pasteboard are now placed, one along each side of the limb, from the hip to the ankle, and another shorter piece on the fore part of the thigh. A double layer of starched bandage should now be applied over the whole, with a strong and well-starched spica. It should be cut up and trimmed on the second or third day, and then re-applied in the usual way. With such an apparatus as this I have treated many fractured thighs, both in adults and in children, without confinement to bed for more than three or four days, and with little if any shortening or deformity being left (Fig. 140). The points to be especially attended to are, that the back pasteboard splint be very strong, at the upper part especially, and that the spica be well and

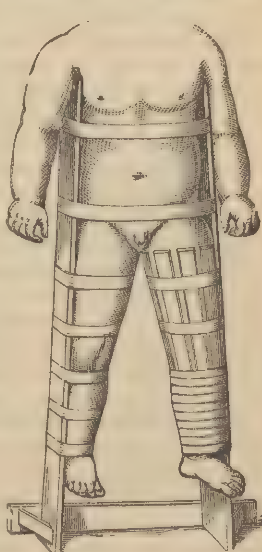


Fig. 186.—Hamilton's Double Thigh Splint with Cross Bar.

firmly applied, so that the hip and the whole of the pelvis may be immovably fixed.

A *simple comminuted* fracture of the thigh-bone is usually best treated on the double inclined plane for the first three weeks, after which it may be put up in the starched bandage.

In fractures of the femur in children, it is often difficult to maintain good position, owing to the extreme restlessness of the patient. In such cases Hamilton recommends that a long splint be applied to the sound thigh as well as to the broken one. The two splints are connected together at the bottom by a transverse bar (Fig. 186). I can speak from experience of its use of the very great advantages of this method in young children.

The **Treatment of Compound and Comminuted Fracture of the Thigh-bone** will vary according as the injury arises from gun-shot, or is an accident of civil life. In the former case, for reasons stated at p. 247, amputation should at once be performed if the fracture be below the upper third of the bone. When the upper third is splintered, the result of amputation is so very unsatisfactory, that the patient may have a better prospect of recovery if the limb be treated in splints, and an endeavor made to save it, disarticulation at the hip-joint in such cases being almost invariably fatal.

When a compound, and even a comminuted fracture of the thigh-bone, occurs from one of the common accidents of civil life, the line of practice is not so defined. The course that the Surgeon adopts must be influenced by the extent of injury done to the soft parts, more particularly to the main bloodvessels of the limb. If the integuments and muscles be extensively torn and lacerated, or if there be reason to believe that the femoral vessels have suffered, amputation must be practised. But if the wound be but small, made by the perforation of the bone rather than by the violence which occasioned the fracture, and if the vessels be uninjured, an attempt must be made to save the limb, which should be put up on the double inclined plane or in the long bracketed splint.

The treatment of the complication of a *wound of the main artery*, femoral or popliteal, with and by a fracture of the thigh-bone, will vary according as the injury is compound or simple. Such an accident, complicating a compound fracture, would probably be a case for immediate amputation. If the fracture be simple, and a diffused traumatic aneurism form in the ham or lower part of the thigh, we must, in accordance with the principles laid down at page 384, ligature the superficial femoral artery, unless gangrene be supervening, or have actually supervened, when the thigh must be amputated above the fracture.

In discussing the treatment of these accidents, in which the question of amputation of the thigh is raised, I cannot too strongly state my conviction that, unavoidable as it undoubtedly is in some cases, as the only alternative left to the Surgeon, this operation, when practised primarily *for fractures of the thigh-bone*, is one of the most fatal in surgery, and should accordingly not be too hastily resolved upon.

3. **Fractures in the Vicinity of the Knee-Joint.**—The lower end of the thigh-bone may be broken across transversely, through the line of junction between the epiphyses and the shaft, both condyles being detached. This most readily occurs in children, from the lower epiphyses not being as yet solidly united to the shaft of the bone. In other cases, the fracture extends through one of the condyles, detaching it from the shaft of the bone. The readiness with which crepitus can be felt, the

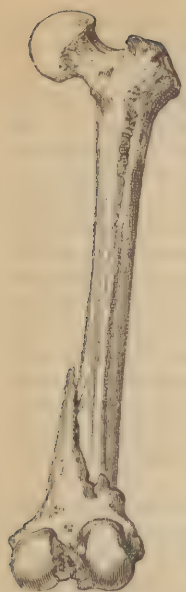
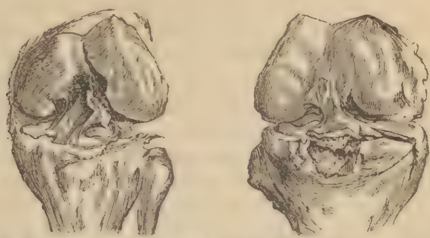


Fig. 187. — Impacted Fracture of Lower End of Thigh-bone.

line of fracture made out, and the displacement removed by lateral pressure, determines at once the nature of this accident.



Figs. 188, 189.—Comminuted Fracture of Condyles from fall on the Bent Knees.

When the femur is fractured transversely immediately above the condyles, the lower fragment is powerfully acted on by the gastrocnemius, plantaris, and popliteus muscles, which flex it upon the tibia, causing its upper extremity to project backwards into the ham, while the lower end of the upper fragment rests on its anterior surface. Thus, although the limb may be apparently extended, the knee-joint is in reality flexed. If a limb in this condition were put up on a long splint and extension made, the displacement would be increased, and non-union of the fracture would very likely result; or, if union did occur, the utility of the limb would be most seriously impaired. By putting the limb on a double inclined plane in a flexed condition the deformity is at once removed, the fractured ends of the bones coming into perfect apposition. I have had several cases of *impacted fracture* in this situation under my care. In one, the upper fragment, which was very oblique, was firmly driven into the cancellous structure of the lower one (Fig. 187). In another case, the condyles of both thigh-bones were splintered into a number of fragments, amongst which the shafts were impacted. Excellent union, however, took place, the skin having been uninjured. In the case from which Figs. 188 and 189 were taken, the patient fell from a great height on the bent knees. In one knee, the anterior crucial ligament had torn up a piece of the tibia, to which it was attached. In the other, the posterior crucial ligament had torn out a piece of the femur, and the bone was fissured a long way up between the condyles.

Fig. 190.—Diagram of Position of fragments in Fracture of Patella. Eversion of Upper Fragment.

Fracture of the lower end of the thigh-bone, communicating with open wound of the knee-joint, is necessarily a case for amputation.

Fracture of the Patella may be the result of direct violence when the bone is often comminuted, or even broken longitudinally, being split, and the joint possibly injured. But most frequently it occurs as the consequence of the sudden and violent action of the exten-

sor muscles of the thigh, in the attempt a person makes to save himself from falling when he suddenly slips backwards. The knee being semi-flexed, the patella rests on it only in its transverse axis, and is readily snapped across, much in the same way as one breaks a stick across some resisting object. All fractures of the patella from muscular action are transverse (Fig. 190). The patient does not break his patella in these cases by falling upon it, but he falls because the patella has been broken by the violent and almost spasmodic action of the extensors of the thigh in his efforts to save himself. In consequence of these fractures being occasioned by muscular action, they are more frequent in men, especially about the middle period of life, less common in women, and extremely rare in children. I have once, however, had under my care a child under ten years of age, who had a transverse fracture of the patella. It not unfrequently happens when one patella has been fractured, that the unsteadiness of gait causes the opposite one to be broken by muscular action in an effort to save a fall. The same patella may be broken more than once; in the cases that I have seen, the second fracture has always occurred in the upper fragment, a little above the line of the original fracture.

The *Signs* of this fracture are very evident. When it is transverse, and has been produced by muscular action, the fibrous expansion over the bone is torn; and the separation between the fragments (Figs. 190, 191), which is much increased by bending the knee (Fig. 192), and the inability to stand or to raise the injured limb, indicate what has happened. When it has been produced by direct violence, the muscles being at rest, there is little or no separation, even though the fracture be transverse. In such cases, and when it is longitudinal or comminuted, the crepitus and mobility of the fragments point it out. Immediately on the occurrence of a transverse fracture of the patella, the knee-joint swells up owing to the effusion of blood into the synovial membrane. This swelling subsides after a few days' rest.

Fig. 191.—Fractured Patella: Side view of Limb, straight.

Fig. 192.—Fracture of Patella: Separation between Fragments increased by bending the Knee.

Mode of Union.—When the bone is broken transversely, it very rarely indeed unites by osseous matter, in consequence of the wide separation of the fragments; there are, however, two or three cases on record in which this kind of union has taken place in these fractures. In the longitudinal and comminuted fractures, osseous union readily occurs, the fragments remaining in close apposition. In the majority of cases of transverse fracture, the fragments remain separated by an interval varying from one-fourth of an inch to an inch; but in some

instances the gap is much greater, amounting even to four or five inches. When the separation does not exceed an inch and a half, the gap is usually filled up by fibrous or ligamentous tissue, uniting the fragments firmly. In some of the cases, however, in which the separation between the fragments does not exceed this distance, and in most of those in which it extends beyond it, W. Adams has found that the fracture is not united by any plastic matter that has been thrown out, but that the fragments are bound together simply by the thickened fascia which passes over the patella, with which is incorporated the bursa patellæ. Adams finds that the aponeurotic structure thus uniting the fragments may be arranged in different ways. Thus it may pass between the fragments, and be adherent to the anterior periosteal surface of both; or the connecting aponeurosis may be reflected over, and be adherent to, both the fractured surfaces; or, lastly (and this is the most frequent form of arrangement), the connecting aponeurosis may pass from the periosteal surface of the upper fragment of the fractured surface of the lower one, to which it becomes closely and firmly united. In the majority of cases, when, united by aponeurotic tissue, the fragments gape somewhat towards the skin, coming into better contact posteriorly. Thus it would appear that a patella fractured transversely may unite in two ways; most frequently by the intervention of thickened aponeurotic structure, and next, by a ligamentous or fibrous band. Of 31 specimens in the London museums, examined by Adams it was found that in 15 aponeurotic union had taken place, in 12 ligamentous union, and in the remaining 4 the kind of union could not be determined.

The aponeurotic union always leaves a weakened limb and an unprotected joint; for, in consequence of the separation of the fragments, the folding in of the fascia, and its adhesion to the capsule of the joint, the fingers can be thrust in between the articular surfaces of the knee.

Treatment.—In many cases of fractured patella, there is rather severe inflammatory action in the knee, with great synovial effusion. This requires to be reduced by rest and the application of evaporating lotions, before any other treatment can be adopted. When this has been effected, means must be taken for the union of the fragments; with this view, the principal point to be attended to is, to keep them in sufficiently close apposition for firm ligamentous union to take place. The upper fragment, which is movable, and has been retracted by the extensor muscles of the thigh, must be drawn down so as to be approximated to the lower one, which is fixed by the ligamentum patellæ. The approximation of the fragments may be effected either by position and relaxation of the muscles, or by mechanical contrivance. Simple position usually suffices for this purpose, and must be attended to whatever mechanical appliances are used. By placing the patient in a semi-recumbent position, and elevating the leg considerably, so as to relax the muscles of the thigh completely, the upper fragment may be brought down to the lower one, and, if necessary, may be retained there, after any local inflammation that results from the accident has been subdued, by moulding a gutta-percha cap accurately to and fixing it firmly upon the knee, or by the application of pads of lint and broad straps of plaster. These straps of plaster may be applied above and upon the upper fragment in a diagonal direction from above downwards. They should be of sufficient length to embrace the limb and the back splint, to which they are to be fixed, or a figure-of-8 bandage may be applied round the limb and splint together. This position must be maintained for at least six weeks; at the expiration of which time the patient may be allowed

to walk about, wearing, however, an elastic knee-cap, or, what is better, a straight leather splint in the ham, so as to prevent the knee from being bent for at least three months. If this precaution be not taken, the union between the fragments, which at first appeared to be in very close contact, will gradually lengthen, until in the course of a few months an interval of several inches may be found between them. In these cases, however, even though the separation between the fragments be great, it is remarkable how well the limb may be used, especially on level ground; and with the aid of a knee-cap but little inconvenience is experienced by the patient.

If the occupation of the patient is such that he cannot be kept at rest during the treatment, the starched bandage will be found very useful, the patient being with it enabled to walk about during the whole of the treatment. The action of the bandage is much increased by drawing down and fixing the upper fragment by two broad strips of plaster firmly applied above it. A back splint of pasteboard is required to fix the knee, and a good pad of lint with a figure-of-8 bandage should be applied above and below the fracture to keep it in position. In several cases I have obtained very close and firm union between the fragments in this way, without confining the patient to bed after the third day.

Various attempts have at different times been made to bring down and to fix the upper fragment, so as to keep it in contact with the lower one; or, if this be impracticable, to shorten the distance between them, and thus to lessen the length of the bond of union. With this view, an apparatus consisting of two broad bands of leather, buckled above and below the knee, and united by longitudinal straps, which can be shortened at pleasure, is very commonly employed. Malgaigne, with the same view, constructed a pair of double hooks, which, being fixed into the two fragments, were drawn together by a screw; and Eve, of Tennessee, accomplishes the same object by means of a ring passed round the fragments. All these means undoubtedly secure the object for which they are intended, and each may be found an useful adjunct to position in any given case. Malgaigne's hooks are undoubtedly the most effectual; but the great objection to their use consists in the pain and irritation that are often induced by their penetration of the skin.


Fig. 193.—Arterial Supply of Patella. (Manning.)

Mr. Manning, late House Surgeon of University College Hospital, has made some very careful dissections of the arterial supply of the patella (Fig. 193). He finds that the vascular arch by which the upper fragment of a broken patella is supplied is situated at the very spot where the greatest amount of pressure is usually applied, and that not unfrequently the internal superior and inferior articular arteries arise from a common trunk, which must inevitably be compressed against the internal condyle of the femur, so that both fragments may thus be starved of blood; and that this want of proper blood-supply has an additional tendency to prevent firm union. As an additional evidence of the compression of the nutrient arteries of the patella by the ordinary apparatus, I may mention that Mr. Manning has found, on injecting a limb thus put up, that all the

arteries were filled except those supplying the patella. In addition to this, Mr Manning is of opinion that, in the ordinary treatment of fractured patella, the apparatus in use does not retain the fragment sufficiently long in position, or control the muscles efficiently.

With the view of remedying these inconveniences, Mr. Manning has constructed the splint (Fig. 194), of which the following is a descrip-

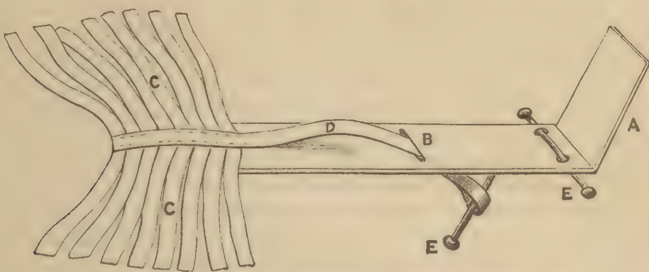


Fig. 194.—Manning's Splint for Fractured Patella.

tion. It consists of a wooden back-piece, a little wider than the knee-joint, and long enough to reach from the sole of the foot to the gluteal fold, and provided at the lower end with a foot-piece, A. At the junction of the middle and lower thirds is a transverse oblique slit, B, one and a half inches long. Strips of strong plaster, two inches broad and long enough to encircle the thigh and overlap by some inches, are attached to a calico band, C. The free end of this band is carried through the slit, and the straps of plaster are open on the upper part of the splint. A piece of wood, E, is attached to the lower part of the splint, and another piece of corresponding size is attached to a loop at the end of the calico band, so that, when drawn down and the splint adjusted, these three pieces may be five or six inches apart.

The foot and leg having been previously bandaged as far as the lower edge of the patella, and the splint padded so as to leave the slit uncovered, the strapping is heated by means of a bottle of hot water (which is more convenient than a strapping-tin), and while an assistant draws down the upper fragment by grasping the muscles of the thigh, the straps

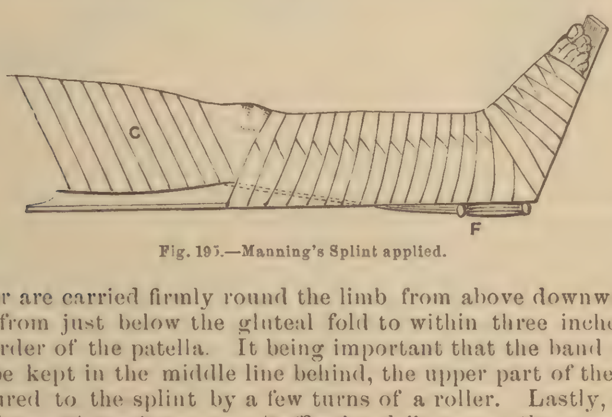


Fig. 195.—Manning's Splint applied.

of plaster are carried firmly round the limb from above downwards, extending from just below the gluteal fold to within three inches of the upper border of the patella. It being important that the band of calico should be kept in the middle line behind, the upper part of the thigh is then secured to the splint by a few turns of a roller. Lastly, as many elastic rings (those known as "office-bands" answer the purpose very

well) as will serve to approximate the fragments without causing too much pain to the patient, are passed over the projecting ends of the pieces of wood, as at F, Fig. 195, on each side of the splint, so as to exercise sufficient traction on the muscles pulling on the upper fragment.

Stiffness of the knee often remains to a very inconvenient degree after the treatment of a fractured patella. It is usually remedied by friction and manipulation. But should it not yield to these minor means, an apparatus consisting of a thigh-and-leg piece of stiff leather, united by angularly hinged lateral iron rods, and having an India-rubber "accumulator," adapted behind, should be worn. The continued traction of the "accumulator" will gradually flex the knee. But, as the knee becomes bent, the close union that may have appeared to exist between the fragments gradually yields, and they gape more or less widely, much to the disappointment often of both Surgeon and patient, the ligamentous band stretching like a piece of vulcanised India-rubber. This cannot be helped. There is the alternative between a straight and stiff knee with close union, or a flexible and mobile one with gaping of the fragments. After the knee is flexible, lateral hinged splints may be worn without the elastic strap. The limb that exists is usually perfectly strong, and good for any exercise except jumping.

In **Simple Comminuted Fractures of the Patella**, the result of direct blows or kicks, the fragments are not much separated, and union takes place readily by bone. In these cases, after subduing inflammatory action, which usually runs high, the starched bandage may be applied, and the knee and fragments thus both kept immovable.

Compound and Comminuted Fractures of the Patella, especially if occasioned by bullet-wounds, and opening the knee-joint, are cases for immediate amputation.

Necrosis of the Patella as the result of fracture is rare. In one such case which was under my care at the Hospital, the patient, a middle-aged man, had met with an ordinary transverse fracture of the patella, which united by ligament; two years after the accident, and without any fresh injury, he came to the Hospital, with necrosis of the outer half of the upper fragment, which was completely detached, and lying in a cavity bounded and shut off from the joint by plastic matter. I cut down upon and removed the necrosed fragment, which appeared to constitute about one quarter of the patella. No cause could be assigned for the necrosis, except defective vascular supply to this part of the bone.

Fractures of the Bones of the Leg.—The bones of the leg are frequently broken, the fracture of the fibula being, as a rule, at a higher level than that of the tibia. When both bones are broken, the fracture is generally situated near the junction of the middle and lower thirds, and the lower fragments are, in the majority of cases, drawn upwards and behind the upper by the action of the gastrocnemius muscle; so that the edge of the upper fragment of the tibia projects under the skin and may perforate it. In some instances, however, the direction of the fracture is such that the lower fragments ride over the front of the upper. The tibia, though a stronger bone than the fibula, is most frequently fractured, owing to its being more exposed and less protected by muscles, and receiving more directly all shocks communicated to the heel. The fractures of the upper part of this bone are usually transverse, and result from direct violence; those of the lower part are oblique, and proceed from indirect violence. When both bones are broken, the usual signs of fracture, such as shortening, increased mobility at the seat of injury, and crepitus, render the diagnosis easy; but when one bone alone

is broken, it is not always a very simple matter to determine the existence of the fracture; the sound bone acting as a splint, prevents displacement, and keeps the limb of a proper length and steady. If it be the tibia alone that has been broken, the fracture may be detected by running the finger along the subcutaneous edge, until it comes to a point that is somewhat irregular, puffy, or tender, where by accurate examination some mobility and slight crepitus may be detected. When the fibula alone is broken, the thick layer of the peroneal muscles, overlaying its upper two thirds, render the detection of the fracture difficult; but in the lower third it is easy, by attention to the same signs that occurred in fractured tibia.

In the **Treatment of simple Uncomplicated Fractures of the Leg,** every possible kind of apparatus has been used. In the majority of cases, where there is but little displacement and swelling, ordinary leg-splints (Cline's, well padded, are extremely convenient) are readily applied and keep the bones in good apposition. These may be kept on for the first few days till all swelling has abated, and then replaced by the starched or plaster bandages. In fracture of the leg, indeed, the starched bandage or the Bavarian splint is especially applicable. The starched bandage should be applied as follows. The limb having been well covered with wadding, a strong soaked pasteboard splint, four inches broad, and long enough to extend from above the knee to six or eight inches beyond the heel, should be applied to the back of the leg. The projecting terminal piece is now to be turned up along the sole of the foot, and two lateral strips adapted, one to each side of the limb. Over this the starched bandage, single or double according to the size of the limb, must be tightly applied. After it is dry, about the end of the second day, it must be cut up as represented in Fig. 142, and re adjusted, and the patient may then walk on crutches with perfect safety. M'Intyre's splint (Fig. 196) will be found of great service in the earlier periods, if

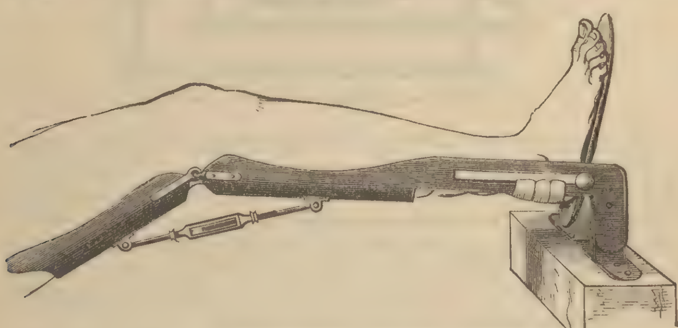


Fig. 196.—M'Intyre's Splint, modified by Liston.

there be much ecchymosis or extravasation, as it keeps the limb in an easy position, and allows the ready application of evaporating lotions. In applying this splint, there are four points that require to be attended to: 1. That the angle be convenient, and suitable to the apposition of the fragments; 2. That the aperture corresponding to the heel be closed by a few turns of a roller in which the heel may rest firmly, but with a certain amount of yielding pressure; 3. That the foot be covered with a flannel sock; and, 4. That the foot-piece be raised and steadied on a wooden block. In some cases of fracture of the bones of the leg, however, M'Intyre's apparatus is not applicable. This is more particularly

the case when the fracture is very oblique, from above downwards, and from before backwards; in these circumstances, the fragments cannot be brought into good position so long as the limb is kept extended and resting on its posterior surface; the bones riding considerably, and one or other of the fractured ends pressing upon the skin in such a way as often to threaten ulceration. In these cases it is, that division of the tendo Achillis has been recommended, with a view of removing the influence of muscular contraction. This appears to me, however, to be an unnecessarily severe procedure, and certainly was not very successful in some cases in which I have practised it: for although the tendon was exceedingly tense, only temporary benefit resulted, the displacement returning under the influence of the other muscles inserted into the foot. In these cases the bones may usually be brought into excellent position by flexing the thigh well upon the abdomen, and the leg upon the thigh, so that the heel nearly touches the nates, and then laying the limb on its outer side on a wooden leg-splint, provided with a proper foot-piece, and keeping it fixed in this position. In some cases the swing-box (Fig. 197)

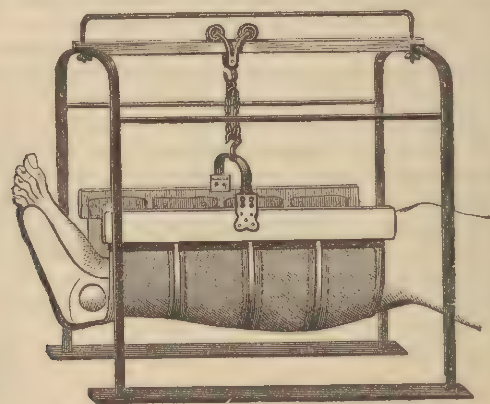


Fig. 197.—Salter's Swing-box for Fractured Leg.

will be found an useful and very easy apparatus. In some fractures of the leg, the lower end of the upper fragment projects considerably, and cannot be brought into proper position so long as the knee is kept bent; but if it be extended, so as to relax the extensors of the thigh, the bone is readily brought into good position. In fractures of the leg, as in all injuries of a similar kind, no one plan of treatment should be adopted exclusively, but the means employed should be varied and suited according to the peculiarities of each individual case.

In the management of all fractures of the tibia, the foot should be carefully kept as nearly as possible at right angles to the leg. If it be allowed to drop, so that the toes point, there will be a tendency for the astragalus to slip forwards from under the malleolar arch; the ankle-joint being thus permanently weakened by the elongation of its anterior ligament.

Should a traumatic aneurism form in the leg, as a consequence of injury of the posterior tibial artery, compression of the superficial femoral in Scarpa's triangle, with pressure by pad and bandage over the pulsating swelling, may succeed. If not, the artery may be ligatured in Scarpa's triangle with good results. Two cases of this kind are recorded, one in the practice of Dupuytren, the other in that of Delpech.

For the treatment of other **Complications of simple Fracture of the Leg,** see pp. 379, *et seq.*

Compound Fractures of the Tibia are of more frequent occurrence than similar injuries of any other bone in the body. This is owing to the thin covering of soft parts over the anterior and inner aspect of the bone, and to the fact of its fracture being usually oblique; so that the sharply pointed end of the upper fragment is liable to be thrust through the integument, when the lower part of the limb falls backwards as the injured person is being raised off the ground. The fracture may, of course, also be rendered compound by the same direct violence that breaks the bone.

The *Treatment* and probable result of the case will in a great measure depend upon the way in which the fracture has been rendered compound, and on the amount of the laceration and contusion of the integuments.

When the wound in the integuments is the result of their transfixion by the point of the upper fragment, it may commonly be closed by the first intention, by laying over it a piece of lint soaked in blood, tincture of benzoin, or collodion, or by using Lister's carbolic acid dressing, after reduction has been effected, and the limb put on a M'Intyre's splint, the lint being left undisturbed as long as possible. Or the limb may be put up in a starched or plaster of Paris bandage, in which a trap is cut to allow the dressing of the wound, as represented in Fig. 143. Should there be difficulty in preventing the protrusion or in effecting the reduction of the pointed fragment, this must be cleanly sawn off, or the wound be enlarged so as to sink it, as directed at p. 386

In the event of there being great contusion and laceration of the soft parts, as when the fracture is rendered compound by a waggon-wheel passing over the leg, it is useless to adopt the routine practice of attempting to close the wound by laying over it a piece of lint soaked in blood or collodion. It cannot unite, as in the other case, by the first intention. Suppuration must take place, and this is best met at once by the application of water-dressing after reduction. Indeed, in cases of this kind, the greatest danger results to the patient from the Surgeon plastering the wound over with a piece of lint rendered hard and impervious with dried blood, or attempting its closure in any other way. The inflammatory discharges are prevented from escaping; and unhealthy pus or broken down blood accumulates in the limb, which becomes greatly swollen, tense, red, painful, and hot. The patient becomes restless; high irritative fever is set up; and, unless relief be given by the evacuation of the pent-up discharges, by opening up the wounds freely, and perhaps by free incisions and counter-openings as well, the worst form of pyæmia will almost inevitably ensue.

If the tibia be much comminuted and the fracture compound, the case is usually one for amputation; but should the patient be young and vigorous, an attempt even in such cases may be made to save the limb. Here a good deal may be done in the way of picking out detached splinters of bone, and sawing off smoothly the jagged and pointed ends of the adherent fragments. The length of the tibia will thus be lessened, and the patient will recover with a necessarily shortened, but otherwise firm and useful limb. Care must be taken in the after-treatment of such cases that too effective extension be not kept up, lest a gap be left between the fractured ends, which cannot be filled up with callus; the consequence being that, in the attempt to obtain good length of limb, want or imperfection of consolidation results.

In both the last classes of cases, tension of the limb from deep abscess,

possibly requiring incision, may ensue; or the consolidation of the fracture and the healing of the wound may be retarded by necrosis of some of the splinters, or of the extremity of one of the fragments, generally the lower one; and not unfrequently, after a proper but unsuccessful attempt to save the limb, the profuseness of the suppuration and the amount of constitutional debility may render imperative secondary amputation above, at, or below the knee.

Hæmorrhage is a common complication of compound fractures of the leg. When venous and moderate in quantity, it may be arrested by position and cold. When primary, arterial, and abundant, proceeding from laceration of one of the tibials, the line of practice to be adopted must to a great extent be determined by the situation of the fracture and of the arterial wound, and the state of the soft parts. If the soft parts be much torn, and the wound be anywhere above the lower third of the limb, it is useless for the Surgeon to attempt to secure the bleeding vessels by groping amongst and under the deep muscles of the limb, infiltrated and disorganised as they are by the injury and by extravasation. It is equally futile to ligature the superficial femoral artery for *primary* traumatic hæmorrhage from the posterior tibial artery. Such an operation either fails in arresting the hæmorrhage, or, if it stop the circulation sufficiently for this, gives rise to gangrene. There is, consequently no resource for amputation; and the sooner this is practised, the better will be the patient's chance of recovery. If, however, the fracture be situated in the lower third, and the artery be torn low down in the limb, where the vessels are superficial, and more especially if the injury be near the ankle-joint, an attempt might be made—provided other circumstances were favorable—to apply a ligature to the bleeding artery, and thus to save the limb. This would be more feasible with wound of the anterior than of the posterior tibial artery.

Fig. 198.—Displacement of Bones and Foot in Pott's Fracture. (Richard.)

But useless as experience has proved the ligature of the superficial femoral to be in *primary* hæmorrhage from the posterior tibial artery in compound fractures of the leg, it is otherwise in *secondary* hæmorrhage: in such cases that artery has been tied with good results, in several instances.

Fractures in the Vicinity of the Ankle-Joint are amongst the most common injuries of the bones of the lower extremity. They are usually occasioned by twists of the foot, by catching it in a hole whilst running, by jumping from a height to the ground, or off a carriage in rapid motion. These fractures are usually associated with severe strain, or even dislocation, of the ankle. Twist of the foot in these cases must not be confounded with dislocation of the ankle. In a twist the foot carries with it the lower fragments of the leg-bones, and the malleolar arch in a more or less perfect state. In a dislocation, the foot is thrown out from under this arch. The twist of the foot is almost invariably outwards, with the inner side downwards and the outer edge turned up, or the sole remains in this direction, though not always to the extent that Dupuytren states,

and the inner malleolus projects under the skin. Most commonly the toes are turned somewhat outwards, and the heel inwards.

Fractures of the lower end of the tibia and fibula present four distinct varieties in degree.

1. The fibula may be broken two or three inches above the malleolus externus, the deltoid ligament being either stretched or torn.

2. The fibula may be fractured about three inches above the ankle, the tip of the malleolus internus being splintered off as well (Fig. 198). This constitutes the form of injury called **Pott's Fracture**, and is perhaps the most common fracture in this situation.

3. The fibula may be fractured about three inches above the ankle, and the lower end of the tibia at the same time be splintered off in an oblique direction from without, downwards, and inwards (Fig. 199).

4. The internal malleolus may alone be broken off, the fibula remaining sound, but one of the divisions of the external lateral ligament being torn through.

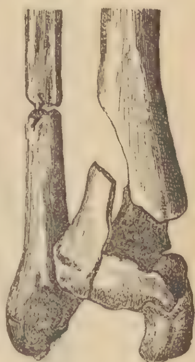


Fig. 199.—Fractures of Tibia and Fibula above Ankle.

The *Signs* of these fractures vary somewhat according to the bone that is injured. When the fibula alone is broken, there is but slight displacement of the foot, but great pain and much swelling, with perhaps indistinct crepitus, and irregularity of outline at the seat of fracture. When the lower part of the fibula is broken, pain is produced at the fractured part by squeezing the bones of the leg together at a point distant from the seat of injury. If the tip of the inner malleolus be broken off as well, this may be ascertained by feeling the depression above the detached fragment. In those cases the crepitus is more distinct, and the displacement of the foot is much more marked, the sole being turned somewhat upwards and outwards, and the patient resting upon its inner side. It is this peculiar twist of the foot with its outer edge turned up, and the inner side down, that constitutes the characteristic sign of Pott's fracture. In those cases in which the lower end of the tibia is obliquely splintered, as well as the fibula broken, there are not only the ordinary signs of fracture, with eversion of the toes, and a corresponding turning inwards of the heel, and some rotation of the foot outwards, but the malleoli are widely separated, giving an appearance of great increase of breadth to the joint; crepitus is very readily felt, and a depression can be perceived corresponding to the line of fracture.

The *Treatment* of these cases is always fraught with difficulty. In consequence of the swelling and inflammation that usually occur, it is often difficult to make out the exact extent and direction of the fracture. This difficulty is greatly increased by the small size and short leverage afforded by the fragments; and so great is it, that in some cases it cannot be overcome by any amount of skill and patience that may be brought to bear on the treatment of the injury, but a certain degree of displacement results as the necessary consequence of the injury, leaving a weak and painful joint, the mobility of which is seriously impaired.

If, as usually happens, more particularly when the fracture results from direct violence, there be a good deal of swelling from ecchymosis and inflammatory action, this will require to be subdued by the continuous application of cold, and the limb should be laid on a splint. If

there be not much displacement of the foot, the treatment may best be conducted by splints with good foot-pieces, and the starched or plaster bandage. When there is no twist of the foot, perhaps the best apparatus is a M'Intyre's splint; or the limb may be put up in lateral leg-splints, with good foot-pieces, and swung in a cradle. I have found the splint, Fig. 200, a very useful appliance in cases of fracture of the bones

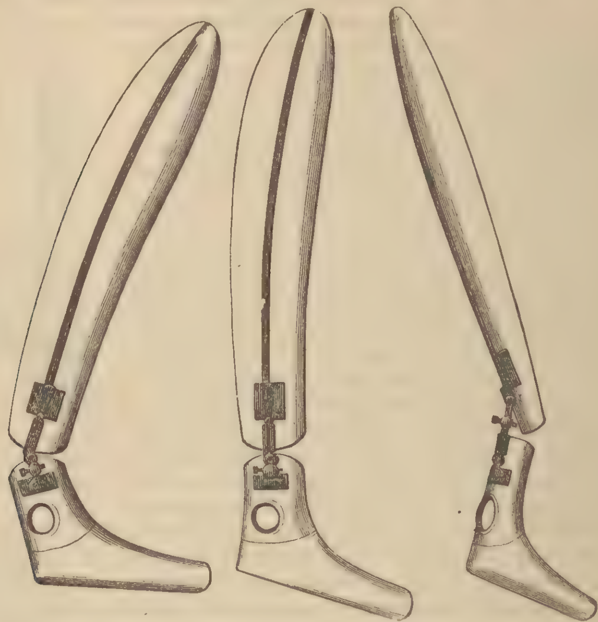


Fig. 200.—Rack and Pinion Splint for Fracture of Lower Third of Leg.

of the leg, one or both, in their lower third. The apparatus consists of an ordinary leg-splint cut across at the upper part of the lower third, the two pieces being united by a double rack and pinion. By means of this mechanism four primary movements can be given to the lower part of the splint, by which the various displacements, that are apt to occur in fractures in this situation, can be counteracted and corrected. Thus the lower end of the splint can be moved backwards or forwards, outwards or inwards (Fig. 200), and by the combined action of the two

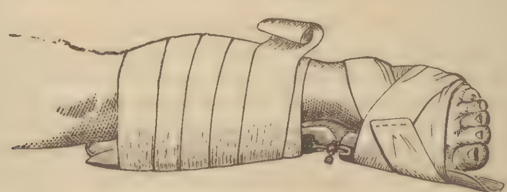


Fig. 201.—Rack and Pinion Leg-splint applied to correct Displacement of Foot outwards.

screws a compound or double movement may be impressed upon the lower fragments of the broken bones. It is in cases of fracture of the lower third of the fibula, with displacement outwards, or of both bones low down with tendency to displacement backwards, that this splint will

be found most useful. It may be applied to either side of the leg, as best seems to suit the case in question. Whatever apparatus is used, care must be taken to keep the sole of the foot nearly at a right angle with the leg. If the toes be allowed to point, it will be found that there is in some cases a tendency for the astragalus to roll forwards, as it were, from under the malleolar arch. In other instances, again, one of the sharp angular fragments connected with the bone may be pressed forwards, and uniting in this position, give rise to permanent deformity. But whatever care be employed, or apparatus applied, it will be found impossible in some cases to replace one of the thin angular fragments, if it become twisted on its axis, and project sharply under the skin.

If the foot be much twisted outwards, as often happens in Pott's fracture, Dupuytren's splint should be applied to the inner side of the limb, so as to counteract the displacement (Fig. 201*). In applying the apparatus, three points require attention. 1. The pad should be folded double at the lower end, and not descend below the ankle, so as to form a fulcrum, across which the foot may be drawn to the inner side. 2. The bandage should not be carried above the knee, but terminate just below the flexure of the joint. 3. The knee should be bent, so as to flex the leg on the thigh, and thus to reflex the strong muscles of the calf, which, by drawing up the heel, and causing the toes to point downwards, offer a serious obstacle to the maintenance of the foot in a good position. Much stiffness is always left after union has taken place, the ankle remaining rigid, weak, and useless for a long time.

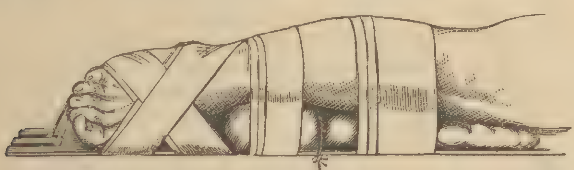


Fig. 201*.—Application of Dupuytren's Splint in Pott's Fracture.

In Pott's fracture, where the malleolar arch is split through, a peculiar deformity is apt to result, consisting of widening of the lower end of the leg by separation of the malleoli. The astragalus is driven upwards, the shaft with the inner malleolus projects somewhat to the inner side, whilst the outer half of the malleolar arch is carried outwards with the lower end of the fibula. The transverse line between the malleoli is increased by half an inch.

Compound Fracture into the Ankle-joint is necessarily a serious and dangerous accident. In this injury, the edge of the fractured bone cuts through the integument by apparently a clean and simple wound, but the subjacent areolar tissue is widely torn, and extensive inflammation and suppuration are apt to set in. The deep-seated mischief is far more extensive than that which the Surgeon would be led to expect from the small and clean-cut wound. Nevertheless, the injury, even though severe, may often be recovered from with a good and useful limb, when occurring to young subjects of sound constitution. As age advances, however, and the constitution becomes broken, less is to be expected from conservative surgery.

In the *Treatment*, the course to be pursued will depend upon the extent of the injury. If the fracture be not much comminuted, the wound in the soft parts clean cut and but moderate in extent, and the large ves-

sels of the foot uninjured, an attempt should be made to save the limb. But if there be great comminution of bone, with dislocation of the foot, and perhaps rupture of the posterior tibial artery, in a person at or above the middle period of life, amputation should be practised. In a young subject, such a serious injury even as this may be recovered from, if the Surgeon remove loose fragments, saw off the splintered ends of the bone, and bring the soft parts together.

If an attempt be made to save the limb, whether any bone have been excised or not, it should be placed securely in a M'Intyre's splint (Fig. 196), and kept immovably fixed; perfect fixity of the limb is here of the first consequence. If much of the fibula should require removal, Stromeyer has recommended that the limb be amputated instead, lest an useless foot, affected with a kind of valgus, be left. But, in children and young subjects, this inconvenience and deformity may be overcome by mechanical means; and the probability of its occurrence would not, in my opinion, justify amputation.

In badly set fractures near the ankle-joint, great deformity with much impairment of the use of the foot may result. In these cases, the inner malleolus will be found to project greatly, the fibula to be curved inwards above its lower third, so as to form a concavity above the external malleolus, and the foot to be somewhat turned outwards (Fig. 202). I have in two instances of such ill-set fractures succeeded in removing the deformity to a considerable extent, even after as lengthened a period as a year and a half or two years, by dividing the fibula subcutaneously by means of a narrow-bladed saw at the seat of greatest concavity, forcibly adducting the foot, and then putting up the fracture in a Dupuytren's splint.

Fig. 202. — Badly set Pott's Fracture, curable by operation.

Fractures of the Bones of the Foot almost invariably result from direct violence, and are usually accompanied by bruising and injury of the soft parts; hence much displacement is rare, and, when the fracture is simple, rest and position alone are necessary. Compound fractures of the tarsal or metatarsal bones, attended by much bruising and laceration, usually require partial removal of the foot, its disarticulation at the ankle-joint, or amputation in the lower third of the leg, according to the extent and severity of the injury.

The **Calcaneum** may be broken by direct violence, as when a person jumping from a height alights forcibly on his heel, and thus fractures the bone. In this way the bone is usually simply broken across in front of the ligaments without displacement. I have, however, seen both calcanea extensively comminuted, being shattered to pieces, in the case of a lady, who, falling from a window on the third story, alighted on her heels. In some rare cases, by the powerful contraction of the strong muscles of the calf, the posterior part of the os calcis is torn away from the rest of the bone.

Signs.—When the os calcis is simply broken through at its posterior part behind the insertion of the lateral ligaments, the detached fragment will be drawn up by the action of the strong muscles of the calf. But

when the fracture occurs across the body of the bone, no displacement can take place, owing to the lateral and interosseous ligament keeping the posterior fragments in position, and preventing its being drawn away.

In the first form of fracture, the pain, swelling, flattening of the heel, and prominence of the malleoli, indicate the nature of the injury, even though crepitus be wanting. In the second variety, the mobility of the fragment, and its projection posteriorly by the action of the muscles of the calf, point to the existence of the fracture, which is confirmed by the occurrence of crepitus.

In the *Treatment* of these injuries, subduing inflammatory action, keeping the part fixed by means of bandages and splint, with due attention to the relaxation of the muscles attached to the tendo Achillis, by flexing the leg and extending the foot, are all that can be done. Union probably occurs by bone in some cases, though very commonly by fibrous tissue.

The **Astragalus** alone is rarely broken. Ten recorded cases of this injury have been collected by Monahan: in nine of these the fracture occurred from falls from a height on the foot; in one only from direct violence. I have seen two cases of fracture of the astragalus without implication of any other of the tarsal bones. In one case it was the result of direct violence; a cart-wheel passing over the foot occasioned a fracture of the astragalus through its neck. There was no material displacement, but the line of fracture could be readily felt, and crepitus was very distinctly elicited on flexing and extending the foot. No better treatment can be adopted in such a case than the starched or plaster bandage.

In the other case the fracture was the result of indirect violence, the patient, a man about 30 years of age, falling from a height of about eight yards, and alighting on his feet. Here his fracture was evidently occasioned by the foot being forcibly driven up into the malleolar arch, so that the astragalus was broken across transversely just in front of the surface that articulates with the tibia—the line of fracture running obliquely downwards and backwards, so that the whole of the upper and posterior part of the bone was detached. This large fragment was widely displaced, being drawn outwards and backwards, so as to lie between the fibula and the tendo Achillis, lacerating the skin to the extent of about one inch longitudinally, and projecting through the opening thus made. The foot presented a singular degree of deformity, which is represented in the annexed figure (Fig. 203). The outer malleolus projected greatly; and immediately behind this the displaced fragment could be felt and seen partially protruding through the rent in the skin. The inner malleolus was depressed: there was a deep hollow below this. The os calcis was apparently turned somewhat towards the inner side of the foot. The sole was arched, the skin much wrinkled, and the great toe forcibly flexed. There was a deep transverse furrow in front of the ankle-joint. In discovering the nature of the accident, and seeing the hopelessness of reduction, or rather the impossibility of maintaining the displaced fragment in position, I cut down upon it by

Fig. 203.—Comminuted Fracture of Astragalus. Displacement backwards.

enlarging the opening through which it showed itself, and then, seizing it with strong bone-forceps, twisted it out, dividing the ligamentous connexions. The case was then treated as one of compound dislocation of the ankle-joint. About a month after the accident, the patient died of pyæmia; and, on examining the foot, it was found that the anterior portion of the astragalus had been splintered into seven fragments, which were retained in place by the pressure of the surrounding parts. No other bone of the tarsus was injured, nor was the malleolar arch fractured. Of this splintering of the anterior fragment, there was no evidence during life; nor was there any reason to suspect it, as there was neither crepitus nor displacement. The extent of the fracture showed the immense force with which the astragalus had been driven into and against the malleolar arch. Were such a case again to occur to me, I should certainly amputate at once.

The only similar case with which I am acquainted is one recorded by Morris. In this the displaced fragment did not occasion a wound of the integument. It was excised owing to the impossibility of reducing it; but the anterior part of the astragalus which was left fell into a state of caries, which spread to the other tarsal bones, rendering amputation of the foot necessary.

The other tarsal bones are but very rarely fractured, except in crushes or gun-shot injuries of the foot. The **Scaphoid** I have once seen fractured by a fall. It was in the case of a man who fell down the shaft of a lift at an hotel, about 60 feet deep, receiving injuries to the chest and spine that eventually killed him. He appeared to have alighted, in the first instance, on the right foot, the os calcis of which was extensively fractured, and the scaphoid broken across without displacement, the astragalus being uninjured.

In all cases of fracture of the tarsal bones, whether simple or compound, with so much displacement as to render reduction difficult and its maintenance impossible, the best course to be pursued is that of cutting down upon and removing the displaced fragment. I know not what else can be done.

Fracture of the Metatarsal Bones usually occurs from direct violence, as by the passage of the wheel of a cart or railway-carriage over the foot, and is then attended with so much laceration and bruising of the soft parts as not unfrequently to render amputation necessary. I have in one instance known the three other metatarsal bones broken by a person jumping from a height. But most commonly their elasticity saves them, and the ankle-joint gives way in such an accident. There is but little, if any, displacement in these cases; and unless the soft parts be so damaged as to require amputation, the support of a starched or plaster bandage is usually all the treatment that is necessary.

CHAPTER XXII.

DISLOCATIONS.

By a *Dislocation* is meant the more or less sudden and complete displacement of one of the bony structures of a joint from the other In the orbicular joints, as the hip and shoulder, the osseous structures may

be completely separated from one another, the dislocation then being **Complete.** In the hinge-joints, as the elbow and knee, the osseous surfaces commonly remain partially in contact, though displaced from their normal relations to one another: here the dislocation is **Incomplete.** In most dislocations the integuments covering the displaced bones are put greatly on the stretch; but in some they are ruptured, and then the dislocation is **Compound.** Besides these varieties, Surgeons recognise **Spontaneous** dislocation, in which the displacement does not occur from external violence. In other cases again, the dislocation arises from **Congenital** malformation of the joint, in consequence of which the bones cannot remain in proper apposition; and finally, d slocation may take place slowly and gradually as a result of disease in the articulation and surrounding tissues: this is termed **pathological** dislocation.

It is customary nowadays to describe dislocations of the distal bone or the more movable bone; formerly, dislocation of the proximal bone was often spoken of.

CAUSES. — Dislocation is **Predisposed** to by various conditions, amongst which the nature of the joint appears to exercise most influence; orbicular joints being more liable to dislocation than any of the other articulations, whilst in some of the synchondroses it never occurs. Malgaigne finds that, of 491 cases of dislocation, 321 occurred in the shoulder, 34 in the hip, 33 in the clavicle, 26 in the elbow, 20 in the foot, besides others in the thumb, wrist, and jaw.

Dislocations are seldom met with in children, in whom fractures through the line of junction between the epiphysis and shaft more readily occur. I have, however, had under my care a child, just one year old, with dislocation of the head of the femur on the os pubis, occasioned by another older child dragging it along the ground by its leg; Kirby and Madge have both seen dislocations of the femur on the dorsum ilii in children of three and three and a half years old; and Travers has seen the hip dislocated in a boy five years of age. In old people the bones are so brittle, and the ligaments so tough, that violence causes fracture rather than dislocation. Hence it is principally in young and middle-aged subjects that dislocations are met with. This is well illustrated by an analysis of 84 cases of dislocation of the hip-joint, collected by Hamilton: of these, 15 occurred under 15 years of age, 32 between 15 and 30, 29 between 30 and 45, and 8 between 45 and 85. They are necessarily far more common in men than in women, from the nature of their respective occupations. Thus, according to Hamilton, of 115 dislocations of the hip, only 11 occurred in women.

The articular ends of the bones of the extremities are kept in their proper positions by the arrangement of the osseous and ligamentous structures of the joints, aided by the continuous tension of the muscles. Considerable external violence may thus be applied to a limb without dislocating it. If, however, the muscles be taken by surprise, or if they have been weakened by previous injury of any kind, the joint becomes predisposed to dislocation, and may be displaced under the influence of very slight causes; especially if it be one where the articulating surface is shallow and the ligaments are comparatively weak. In this way the same joint may be repeatedly dislocated. Thus I have seen a man whose humerus had been dislocated between forty and fifty times, owing to a weakened state of the deltoid.

The **Direct Causes of Dislocation** are *external violence* and *muscular action.* *External violence* may act directly upon a joint, forcing or twisting the articular ends asunder, as happens when the foot is dis-

placed by a twist of the ankle, or when the thumb is dislocated backwards by a blow. But more commonly the force acts at a distance from the joint that is displaced, and the head of the bone is thrown out of its socket by "the lever-like movement of the shaft," as happens when the head of the humerus is dislocated by a fall on the hand, or when the head of the femur is dislocated.

Muscular action alone may cause the dislocation of a bone, even though the part be previously in a sound state. Thus, the lower jaw has been dislocated by excessive gaping, and the humerus by making a violent muscular effort. If the joint have already been weakened by previous injury or disease, muscular action is especially apt to occasion its displacement. Congenital dislocations, in all probability, arise from irregular muscular contractions in the fœtus, by which the bones are displaced, and the normal development of the joint is interfered with. In dislocations of the orbicular joints, after the head of the bone has been thrown out of its articular cavity, it is often still further displaced by the contraction of the muscles, which continues until they have shortened themselves to their full extent, or until the dislocated bone comes into contact with some osseous prominence that prevents its further displacement.

Signs.—The existence of a dislocation is rendered evident by the change in the shape of the joint, and in the relation of the osseous prominences to one another: by the articular end of the displaced bone being felt in a new position; and by an alteration in the length of the limb, and in the direction of its axis. Besides this, there are after a time, if not immediately on the occurrence of the accident, impaired motion, both active and passive, of the injured articulation, and pain in and around it. It should, however, be borne in mind that fracture may exist with the dislocation; hence the mobility may be increased.

Effects.—The effects of dislocation on the structure of a joint are always serious. The bones are not unfrequently fractured as well as displaced, more particularly in hinge-joints: the cartilages may be injured; and the ligaments are always much stretched and more or less torn, the capsule of the joint suffering especially. This is always torn by the pressure of the head of the bone in dislocation of orbicular joints; in those of hinge-joints, it may escape. The situation of the slit in the capsule is of great importance in reference to reduction. It commonly occurs in the shoulder towards the attachment around the glenoid cavity; in the hip, as Busch has pointed out, at the acetabular margin. In many cases, the muscles and tendons in the immediate neighborhood are lacerated as well as displaced, and the vessels and nerves compressed. The skin is commonly stretched, and sometimes ruptured, when the dislocation becomes *compound*. If the dislocation be simple, and if reduction be speedily effected, the injuries are soon repaired; and although a good deal of stiffness may continue, the functions of the joint are, in general, not permanently interfered with.

If the dislocation be left unreduced, important changes take place within and around the joint, in the bony structures, the ligaments, capsule, and muscles. The changes in the bony structures are very slow, differing in this respect materially in ordinary traumatic dislocations, from what takes place in a joint that has been dislocated as the result of disease. If the articulation be an orbicular one, as the shoulder or hip, the cavity, whether glenoid or acetabular, undergoes very gradual changes in outline and depth; its circumference becomes contracted, less regular, more angular, and the hollow eventually shallows. These changes are so slow in the adult, that several years will elapse before

they have gone on to such a degree as to prevent the displaced head of the bone from being put back. In children and young people they are more rapid and complete, and the cavity fills up with a dense fibrous deposit. In the hinge joints, the articular ends of the displaced bones become altered in shape—flattened or angular, with the osseous projections less strongly marked. The incrusting cartilage is gradually absorbed, and the bone smoothed. The ligaments are shortened and wasted; and a false joint forms around the articular end of the bone in its new situation. In some cases, the bone upon which the dislocated head rests becomes depressed into a shallow cup-shaped cavity, so as to receive it; in others the depression is formed by the elevation of a rim of callus upon the adjacent bone; and in both instances the areolar tissue in the neighborhood becomes consolidated into a fibroid capsule surrounding and fixing the bone in its new situation, and usually admitting of but a limited degree of motion. The soft structures that have been lacerated at the time of the dislocation become matted together by plastic material; the muscles shorten, atrophy, and at last undergo fatty degeneration from disuse: the neighboring vessels and nerves may become attached to the new joint, or their sheaths become incorporated with the altered structures in contact with them.

Treatment.—In the treatment of dislocations, the first and principal indication consists in replacing the bone in its normal situation as speedily as possible. In doing this, the Surgeon has two great difficulties to overcome: 1, the contraction of the muscles of the part; and 2, the resistance arising from the anatomical structure of the joint and the laceration of the capsule.

1. One great obstacle to reduction in most dislocations is the tonic *contraction of the muscles* inserted into or below the displaced bones; and in the reduction of the dislocation the Surgeon's efforts are chiefly directed to overcome this contraction. The amount of resistance due to muscular contraction may be measured by the efforts produced by anæsthetising the patient. So much of the resistance as is overcome by putting the patient under the influence of ether or chloroform, is due to muscular contraction. All that which continues after this, is due to purely mechanical causes connected with the arrangement of the osseous and ligamentous structures of the joint, or with the injury inflicted on them. The resistance offered by the muscles is of several different kinds, and is dependent on different causes. The influence exercised by the patient's will, and the tonic contraction or passive force exerted by the shortened and displaced muscles, undoubtedly often offer great obstacles to reduction. But more serious than these by far is the reflex or spasmodic action, which the patient is unable to control, and which can only be overcome by force, by faintness, or by the paralysing influence of anæsthetics. The longer the dislocation is left unreduced, the more powerful does the resisting force become; being less at the moment of the accident and immediately afterwards, than at any subsequent period. Hence reduction should be attempted as soon as possible after the occurrence of the accident; and, if the patient be seen at once, the bone may sometimes be replaced without much difficulty by the unaided efforts of the Surgeon. Thus Liston reduced a dislocated hip by his own endeavors immediately after the accident occurred. If a few hours have elapsed, the muscular tension becomes so great that special measures must be adopted in order to diminish it; and if some weeks or months have been allowed to pass by, the dislocation may have become irreducible, partly owing to permanent secondary contraction of the muscles

which have been shortened, which it is impossible to overcome, but chiefly to the matting together of the surrounding tissues, and the formation of adhesions about the head of the bone. The muscular resistance is greatest when an attempt is made at reduction by forcible traction in the direction of the longitudinal axis of the limb, and parallel to the course of the muscles.

In the reduction of a recent dislocation, advantage may sometimes be taken of the occurrence of faintness, or of the patient's attention being distracted to other matters, the muscles being then taken, as it were, by surprise, and the bone readily slipping into its place. Such aids as these, however, cannot be depended upon; and muscular relaxation should be induced by the administration of chloroform or ether. By the employment of these valuable agents, the muscles of the strongest man may be rendered so perfectly flaccid and powerless in a few minutes as to offer no opposition whatever to reduction, which is thus wonderfully simplified and facilitated. In no department, indeed, of practical surgery has the administration of anæsthetic agents been attended by more advantageous results than in this.

Mechanical contrivances are much less frequently used for the reduction of dislocation, since the employment of anæsthetics, than formerly. It is, however, occasionally necessary to employ apparatus calculated to fix the articular surface from which the bone is dislocated, and to draw down or disentangle the displaced bone to such an extent that it may be replaced on the surface from which it has escaped. If the patient have not been anæsthetised, it will be found that, when the bone is well brought down by the extending force so as to be opposite its articulation, and disentangled from osseous points upon which it may have hitched, or from the edge of the slit in the lacerated capsule, it will be drawn at once into its proper position by the action of its own muscles, with a sudden and distinct snap; the muscles of the part being the most efficient agents in the reduction, so soon as the bone is placed in a position for them to act upon it. When, however, the patient has been placed under the influence of chloroform, the muscular system being thoroughly relaxed, the bone will not slip into its place with a snap or sudden jerk, but is reduced more quietly, and rather by the efforts of the Surgeon than by any sudden contraction of its own muscles. It is important to note these differences in the mode of reduction; lest the Surgeon, when chloroform has been fully administered, failing to hear the snap or feel the jerk which he expected, imagining that the bone has not been reduced, should continue to use an improper degree of extension.

Manipulation of the limb—that is, impressing upon it certain movements of extension and flexion, of adduction and of abduction—is often of essential service in effecting reductions. It is useful in those cases, particularly, where the obstacle to replacement of the head of the bone is due less to muscular contraction than to the locking together of osseous surfaces, or the impediment offered by the displacement of the ligaments of the part. In the hip, elbow, and knee it has been especially serviceable, and has now taken the place of many of the more formal methods of reduction by extension in the axis of the limb, with the view of overcoming forcible resistance offered by muscular contractions or capsular entanglement.

Reduction of Dislocations of Hip by Manipulations is first described by Thomas Anderson, Surgeon, of Leith, in the third volume of "The Medical and Philosophical Commentaries," for 1775. He describes two

cases, one of dislocation on the foramen ovale in a man—the other a dislocation on the dorsum illi in a boy.

In the first case the pulleys had been used ineffectually several times, when the "lacque" slipping, their use was discontinued. Mr. Anderson says: "I was convinced that attempting the reduction in the common method, with the thigh extended, was improper, as the muscles were put upon the stretch, the action of which is perhaps sufficient to overcome any extension we can employ. But by bringing the thigh to near a right angle with the trunk, by which the muscles would be greatly relaxed, I imagined the reduction might more readily take place, and with much less extension.

"*I raised the thigh to about a right angle with the trunk*, and, with my right hand at the ham, laid hold of the thigh, and made what extension I could. At the same time that I did this, with my left hand at the head and inside of the thigh, I pressed it towards the acetabulum, while my right gave the femur *a little circular turn*, so as to bring the rotula inwards to its natural situation, and at the second attempt it went in with a snap."

In the second case, the reduction was not attempted till the eighteenth day after the accident. The patient was laid across the bed, and *the thigh raised so as to form an acute angle* with the trunk. In this situation, the knee of the dislocated limb lay considerably over the sound thigh. "Considerable extension was then made; with my left hand I laid hold of the middle of the leg which I brought inwards. By this *the femur made a circular turn*, which directed its head towards the acetabulum, into which it went with a sensible noise" (pp. 426—428).

The purely mechanical means for the reduction of dislocation are sufficiently simple: the patient's body, and the articular cavity into which the luxated bone is to be replaced, are fixed by a split sheet, a jack-towel, a padded belt, or some such contrivance, by which *counter-extension* is practised. In some cases the hands of an assistant, or of the Surgeon himself, or the pressure of his knee or heel, constitute the best counter-extending means.

Extension may be made either by the Surgeon grasping the limb to be reduced and drawing it downwards, or else by means of a bandage or jack-towel fixed upon the part with the clove-hitch knot applied in the way represented in the annexed cut (Fig. 204). If more force be required, the multiplying pulleys (Fig. 229), or Bloxam's dislocation tourniquet (Fig. 233), may be used, by which any amount of extending force that may be required can readily be set up and maintained. Jarvis's "adjuster" is an useful and powerful instrument for the same purpose. These contrivances, however, are much less frequently required now than formerly, owing to Surgeons taking advantage of the paralysing effects of chloroform upon the muscular system, and consequently not requiring so much force to overcome its contraction, and employing the gentler method of *manipulation*, by which resistance is eluded by attention to ordinary mechanical

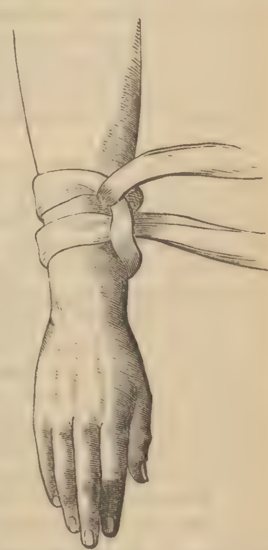


Fig. 204.—Bandage applied for Extension: Clove hitch Knot.

principles, rather than overcome by force. When any powerful extending force is applied, the skin of the part should always be protected from being chafed by a few turns of a wet roller. The extension must be made slowly and gradually without any jerking, so as to secure equality of motion as well as of traction. In this way the contraction of the muscles is gradually overcome, whereas sudden and forcible extension might excite them to reaction. The traction is most advantageously made in the newly acquired axis of the limb, without reference to its normal direction or to the situation of the joint. The head of the bone is thus made to pass along the same track which it has torn for itself in being dislocated, and thus is replaced without the infliction of any additional violence on the surrounding tissues.

The question whether the extending force should be applied to the bone that is actually displaced, or to the further end of the limb, has been much discussed, and appears to have received more attention than it deserves. It is true that, by applying the extending force to the displaced bone itself, the Surgeon has greater command over its movements, with less chance of injury to the intervening bones; whilst, by applying the extending force to the lower part of the extremity, he has the advantage of a longer lever for the reduction of the head of the bone. This lever, however, it must be remembered, is in many cases a broken one; and it cannot be made to act if the bone have to be replaced in the direction of the flexion of the joints that exist in its course. For this reason, we find that some dislocations are best reduced by applying traction to the bone itself that is displaced, as in luxations of the femur and of the bones of the fore-arm; whilst, in other cases, as in the dislocations of the humerus, most advantage is gained by applying the extending force to the end of the limb. But I look upon these points as of comparatively little consequence; believing that, when the patient is not anæsthetised, the muscles of the limb themselves effect the reduction, without the necessity of the Surgeon employing any very powerful lever-like action of the bone; and that, when the patient is paralysed by chloroform, the bone is in most cases readily replaced by the simple movements impressed directly upon it, or even upon its articular end, by the hands of the Surgeon.

The force required in effecting the reduction of recent dislocations is often very considerable. So great is the resistance offered, that in some cases the dislocated bone has given way under the traction. I am acquainted with cases in which the humerus and the neck of the femur have both been broken in effecting the reduction of *recent* dislocations. This accident does not always appear to have been the result of any improper or unskilful employment of force, but in some cases to have occurred from natural weakness of bone. We know that "spontaneous" fractures frequently take place from muscular action, often of a very slight kind: and we can easily understand that, if a bone that would be liable to such ready fracture happened to be dislocated, it would almost of necessity give way under the influence of the extending or lever-like force required to replace it.

2. The reduction of dislocations is also impeded by the mechanical resistance arising from *the anatomical structure of the joint and its ligaments*. In reducing a dislocation, it is of especial importance to attend to the relation of the osseous points in the neighborhood of the joint, and to disentangle the displaced bone from any of these upon which it may be lodged. This is especially the case in such hinge-joints as the jaw and elbow, in which the arrangement of the articulation is some-

what complicated; and in some orbicular joints, as the hip, where the reduction is prevented by the displacement and tension of torn ligamentary structures. When the patient is anæthetised, and all muscular resistance has thus been removed, any remaining difficulty in effecting reduction must be due to purely mechanical causes dependent on the disarrangement of the bones and ligaments. Under the older methods of treatment, where much force was employed by pulleys and other similar contrivances, these were often torn through. But, since the introduction of *manipulation*, the Surgeon effects the reduction by a far less degree of force, replacing the bone on simple mechanical principles, by relaxing the ligaments and disentangling the bones from one another. The situation and extent of the laceration of the capsule of the joint are also of great importance as offering an obstacle to reduction, in some cases constricting the neck of the bone, in others having one lip of the slit pressing against the bone in such a way as to resist all efforts to move it. An extreme degree of force is required to tear through and thus overcome obstructions of this kind; but they may readily be relaxed and slipped aside by skilful manipulation and attention to the position of the limb.

After the dislocation has been reduced, the bone must be retained in position by proper splints and bandages; the joint being kept quiet for two or three weeks, according to its size, so as to allow proper union to take place in the capsule and neighboring structures. Any consecutive inflammation may often be prevented by the continuous application of cold; and, if set up, must be treated by local antiphlogistic measures. After reduction, the limb must be kept firmly fixed and at rest for two or three weeks, so as to allow the lacerated ligaments and capsule to recover themselves. But fixation of the joint must not be maintained for too long a time, lest adhesions, often of a painful character, form. These may be avoided by passive motion. If they have formed, they may readily be broken down by the manipulations commonly employed in such cases by "bone-setters," who, fixing the joint by pressure of the thumb on the painful spot, in a manner well described by W. Hood, impart sudden and forcible movement to the limb, by which adventitious bands are ruptured.

Dislocations of Old Standing.—If a dislocation have been left unreduced for some weeks or months, changes, which have already been described, take place in and around the displaced articular structures, the double effect of which is to render the replacement of the bones in their normal position more and more difficult as time goes on, and to lead to the formation of a new though imperfect articulation at the seat of the displaced bone.

When a dislocation has been left permanently unreduced for a considerable length of time, as for years, the amount of utility in the limb will depend partly on the kind of joint that has been dislocated, partly on the particular variety of dislocation that has occurred. Thus, as a general rule, greater freedom of movement and greater utility of limb will be found in old-standing dislocations of ball-and-socket than of hinge-joints. But in ball-and-socket joints some dislocations will, if left unreduced, be attended with less evil consequences to the patient than others. Thus, in the *subglenoid* dislocation of the shoulder and the *sciatic* of the hip, the limb will recover itself to a greater extent than in the other forms of the same kind of injury affecting these joints.

Treatment.—In cases of very old and irremediable unreduced dislocation, much may be done by means of regularly conducted passive move-

ments to increase the mobility of the part, and by means of friction and warm douches to relieve the tension and painful stiffness. In cases not so old, but in which some time has elapsed since the occurrence of the dislocation, two questions always present themselves to the Surgeon:—1. Is it possible to replace the dislocated bone? 2. Is it desirable or prudent to attempt reduction?

The possibility of reducing the dislocation will depend partly upon the joint that is dislocated and the nature and extent of the dislocation, but chiefly on the length of time during which the bone has been out of place. Dislocations of the orbicular joints generally can be reduced at a much later period than those of the ginglymoid; those of the shoulder can be reduced after a longer lapse of time than those of the hip. The subglenoid dislocation of the shoulder and that of the hip on the dorsum ilii are capable of reduction at a later period than the other luxations of the same joints.

The *latest period* at which reduction is possible has been variously estimated by different Surgeons. Sir A. Cooper gives three months for the shoulder and eight weeks for the hip. As a general statement, this was no doubt tolerably correct at the time when it was made, although reduction had been effected at later periods than those given by Cooper. Thus Breschet reduced a dislocation of the hip at the 78th day, and Travers at the fifth month. But we may now under anæsthesia go far beyond this as the limit of *possible* reduction. Brodhurst has reduced the shoulder on the 175th day; Smith (U. S.) in one case at the seventh month, in another ten months and a half; Blackman of Cincinnati, a dislocation of the femur on the dorsum ilii at six months; Dupierris of the Havana, one at over six months, in a boy, and this without chloroform; and R. W. Smith, after nine months had elapsed.

The **Obstacles to the Reduction** of old-standing dislocations are rather pathological, than physiological and anatomical as in the case of recent displacements. They are of several distinct kinds:—1. The powerful tonic contraction of the shortened and displaced muscles; 2. The organic changes that have taken place in these muscles, arising partly from their contraction of the tissue thrown out to repair the laceration, partly from a kind of rigid atrophy, the consequence of inflammatory action and of disease; 3. Adhesions that form between the lacerated capsule and the muscles and the displaced head of the bone; 4. Lastly, as a more remote effect, pathological changes in the articulating surfaces themselves, by which their shape becomes altered and the socket shallowed, contracted, and perhaps ultimately obliterated by fibroid deposits.

In order to overcome these obstacles a considerable amount of force must be used, as adhesions and contractions have to be stretched and torn asunder. This is effected by the multiplying pulleys and by manipulation under chloroform. In employing the necessary force, care must be taken to protect the skin from abrasion, or even laceration, by the use of wet flannel bandages or wash-leather. The force exercised by the pulleys must be considerable; but it should be accompanied by free rotatory manipulations and movements of the head of the bone, so as to loosen it from its adhesions; and reduction will usually be effected in this way rather than by forcible traction only.

Anæsthesia is of inestimable service in these cases; and it is by its means that the Surgeon has been enabled to prolong materially the limit of possible reduction. But, in the reduction of old dislocations, anæsthetics do not afford exactly the same kind of service as in those of recent date. In a recent dislocation the chief obstacle is muscular

contraction; and, by relaxing this anæsthetics enable the Surgeon to replace the bone at once without difficulty. In old dislocations the obstacles, as has just been stated, consist in various pathological changes that have taken place around and in the displaced bones. These conditions cannot be influenced by anæsthesia; and hence, except as a means of producing insensibility to pain and preventing instinctive or voluntary muscular resistance, choloroform will not aid the Surgeon.

It must be borne in mind that the reduction of old dislocations is not only a work of very considerable difficulty, but also of considerable danger. If several months have elapsed, the obstacles arising from the pathological changes already mentioned will usually be so obstinate as to render the reduction impossible without the employment of a dangerous amount of force, and in many cases they will prevent the possibility of reduction, whatever force be employed.

The **Accidents** liable to occur during attempts to reduce old dislocations, whether successful or not, are the following:—1. Laceration of the skin by the constriction and pressure of the bands to which the pulleys are attached. 2. Laceration of muscles: thus the pectoral has been torn through in attempting reduction of old dislocation of the shoulder. 3. The development of inflammation and suppuration around the dislocation, by the violence to which the soft parts have been subjected. From this cause death has several times resulted, in attempts at reducing old hip-dislocations. 4. Extensive extravasation of blood from the rupture of small vessels in the lacerated soft parts, giving rise to wide-spread ecchymosis. 5. Laceration of one of the larger veins. A patient of Froriep's died from this cause, after rupture of the axillary vein, in an attempt to reduce an old dislocation of the shoulder. 6. Laceration of an artery, and the formation of a diffused traumatic aneurism. This serious accident has happened at least twelve times in attempted reduction of old dislocations of the shoulder. The brachial artery has also been torn in attempted reduction of dislocated elbow. 7. Laceration of neighboring nerves. Those of the axillary plexus have been torn in attempted reduction of dislocation of the shoulder, and the median in that of the elbow. 8. Fracture of the dislocated bone. This serious accident has usually happened when the Surgeon, after the employment of extension, has attempted to put in force transverse movements of the bone, or has used the bone as a lever; when it has given way, usually high up near the head, at other times in the shaft. It is possible that in some cases this may have been predisposed to by the bone having become weakened by want of use. It has occurred several times in the humerus, and at least eight times in the femur, in attempts at reducing old dislocations of these bones. In most of the recorded cases the bone has readily united, and the condition of the patient has not been materially, if at all, influenced for the worse, except that reduction of the dislocation has necessarily been rendered impossible. 9. Neighboring bones have been fractured, such as the ribs and the glenoid cavity in the endeavor to reduce dislocation of the shoulder, and the acetabulum in attempted reduction of a luxated hip. 10. The limb has actually been torn off. This remarkable and distressing accident happened to Guérin of Paris, in attempting the reduction without pulleys, and merely by the traction of assistants, of a dislocation of the shoulder of three months' standing, in a woman 63 years of age, the limb being suddenly torn off at the elbow. On examination, the bones were found porous, the muscular and other soft structures pulpy, the limb having thus evidently lost its natural strength and elasticity.

The occurrence of these various accidents and injuries, in the attempted reduction of old dislocations, cannot always be justly attributed to the employment of an improper degree of force by the Surgeon. The liability to them must rather be looked upon as a necessary and inevitable accompaniment of all attempts at putting back into its place a bone which has been dislocated, and left unreduced for many weeks or several months. During this period the bone usually contracts adhesions of a very dense kind to the parts amongst which it lies; and, as it cannot be replaced in its articular cavity until these adhesions have been torn or broken through, it is easy to understand how, in the attempt to do this, neighboring soft parts, vessels, or nerves may give way, or the bone itself may yield to the force that must be applied to it in order to lift it out of its new bed.

The liability to the occurrence of these accidents should make the Surgeon very cautious how he recommends the attempt at the reduction of old-standing dislocations. If after a time the new joint have become tolerably mobile, and be not painful, it may be better to leave the bone unreduced, rather than expose the patient to great risk, with a slender prospect of eventual success. If the unreduced dislocation be stiff and painful, much may be done by passive motion, frictions, and douches, to improve the patient's condition.

The **Subcutaneous Section** of muscles, tendons, and bands of adhesions in the neighborhood of the dislocated joint, has been proposed by Dieffenbach as a means of facilitating reduction in old-standing cases; and he relates an instance in which, by these means, a shoulder that had been dislocated for two years was reduced. In many cases in which this plan has been tried, the success has not been commensurate with the expectations raised respecting it; and in other instances, of which I have seen two or three, the operation has been followed by sloughing and other serious evils, while it has not been attended by any benefit in facilitating reduction.

COMPOUND DISLOCATION is one of the most serious injuries to which a limb can be subjected. Not only is there such extensive laceration of the soft parts that cover and enter into the formation of the joint as to give rise to the most severe forms of traumatic arthritis, but the bones are ofted fractured, and the main vessels of the limb perhaps greatly stretched or torn.

The *Treatment* of a compound dislocation must be conducted on the same principles that guide the Surgeon in the management of a wounded joint, viz., cold, or antiseptics, with drainage to secure the free escape of the inflammatory products. Owing to the rupture of the ligaments and of the muscular attachments, there is usually no difficulty in the reduction, the bones being readily replaced; but the danger consists in the destructive inflammatory action that will be set up in the joint and limb from the extensive injury inflicted upon them. This varies greatly, according to the size and situation of the joint, and the state of the soft parts. If the joint be small, as one of the phalangeal articulations, the dislocation may be reduced, and the parts covered with cold lint. If it be one of the larger joints, the line of practice will vary according to other circumstances than the mere dislocation. Thus, if it be in the upper extremity, the patient being healthy, and the soft parts not very extensively contused or torn, the bones may be replaced, cold irrigation assiduously applied, and antiphlogistic treatment pursued. If there be fracture conjoined with the dislocation, resection should be practised, as was successfully done by Hey in several cases of injury of the elbow of

this description; but if the soft parts be greatly injured as well, and especially if the blood-vessels and nerves of the limb have suffered, amputation must be performed. In the lower extremity, amputation is more frequently necessary; in the knee, almost invariably so. Sir A. Cooper states that he knows no accident that more imperatively demands amputation than compound dislocation of this joint. Yet there are exceptions to this rule; thus, White had a case of compound dislocation of the knee-joint in a boy, nine years of age, at the Westminster Hospital, in which he saved the limb by sawing off the condyles of the femur and reducing the bone. In the compound dislocations of the ankle and the astragalus, an attempt should generally be made to save the limb, in the way that will be more specially pointed out when we come to treat of these injuries.

After recovery from compound dislocation, the joint will often remain permanently stiffened; hence attention to position during the treatment is essentially required. In many cases, however, very good motion is ultimately obtained, though the stiffness may continue for some length of time.

Complications.—**Fracture of the Shaft of one of the Long Bones with Dislocation of its Head** increases considerably the difficulty of reduction. In these circumstances, it has been recommended to consolidate the fracture first, and then to attempt the reduction. But to do this is only to defer and increase the difficulties. At least seven or eight weeks must elapse before the fracture will be sufficiently firmly united to bear the requisite traction to reduce so old a dislocation; and then there will be great chance of rupture of the callus, and there will certainly be extreme difficulty in the reduction. It therefore appears to me much safer, under all circumstances, to reduce the dislocation at once, and afterwards to treat the fracture in the usual way. In reducing a dislocation complicated with fracture of the shaft of the displaced bone, the fracture must first be put up very firmly indeed, with wooden splints completely encasing the limb. The patient must then be put fully under the influence of chloroform, which is of the most essential service in these cases; and, when the muscles are completely relaxed, extension and counter-extension being made in the usual way, the reduction may be effected. The extending means should always be applied upon the splints, so that there may be no dragging upon the fracture. In this way I have reduced, without any difficulty, a dislocation of the head of the humerus into the axilla, complicated with comminuted fracture of the shaft of the bone, in a remarkably muscular man to whom I was called by Byam; and about the same time I had under my care at the Hospital a case of dislocated elbow, with fracture of the shaft of the humerus, that was reduced with ease in the same way. The difficulty in reduction is necessarily increased by the proximity of the fracture to the dislocated joint; and when the epiphysis is broken off from the shaft and dislocated, the difficulty may be great, but is not insuperable. Some years since, I assisted H. Smith and Dunn in the reduction of a dislocation of the humerus with fracture of the surgical neck of the bone, the displaced head lying to the inner side of the coracoid process. In this case the patient, a young man who had sustained the injury by a fall in an epileptic fit, was put under chloroform, and when he was fully anæsthetised the displaced head of the bone was easily replaced; the patient recovering with an excellent and useful arm. After the bone has been reduced, the fracture should be treated in the ordinary way.

When a **Simple Fracture extends into the Articular End of the Bone**, as in some dislocations about the elbow and ankle, there is no material increase in the danger of the case or in the difficulty of its management.

In **Compound Dislocation with Fracture of the Articular Ends**, removal of splinters, and partial resection or amputation, will be required according to the seat and extent of injury.

SPONTANEOUS DISLOCATIONS may occur either suddenly or gradually, according to the nature of the cause that gives rise to them.

Spontaneous dislocation, if that term can be properly applied to such cases, is often met with on the hip as the result of old disease. The ligamentous and cartilaginous structures having become destroyed, the head of the bone atrophied and absorbed, the articular surfaces become readily displaced under the influence of slight muscular action.

There is, however, a second and more rare form of spontaneous dislocation to which the hip and shoulder are liable, and which has been especially studied by Stanley. In this dislocation the head of the bone slips out of the articulation without any very marked signs of disease about the joint, and certainly without any previous destruction of it. In these cases there is either a *paralytic condition of the capsular muscles*, as has been observed several times in the shoulder, the deltoid having become paralysed and thus having allowed the bone to slip out of place; or, as has been noticed in the hip, *obscure* or *rheumatic neuralgic pains* have for some time been seated in the joint. The dislocation may not be confined to one joint, but may affect several. Thus, some time ago there was a case in University College Hospital, in which both shoulders and hips were dislocated simultaneously. In many cases it occurs suddenly, and often without any pain, the deformity of the limb attracting attention; though in others it has been preceded by rheumatic affection of the joint.

There is a third variety of spontaneous dislocation, in which, the joint having become dislocated and reduced, the muscular and ligamentous structures have become so weakened that ever afterwards it slips out of place on the application of slight force, or at will on the patient throwing the muscles of the limb into action.

The *Treatment* of these cases is not very satisfactory. Reduction in many cannot be accomplished; while in others it may be effected readily enough, but the bone cannot be fixed in the joint out of which it slips again. In a case of spontaneous dislocation of the hip, without any apparent disease of the joint, occurring in a young woman, I readily effected reduction by the pulleys, three weeks after the occurrence of the displacement. The limb was then fixed with the long splint, and maintained at a proper length for two or three weeks; when, in consequence of a severe bronchitic attack, it became necessary to remove the apparatus, and the displacement speedily returned. Whilst convalescent from this attack, the patient fell and fractured the displaced femur in its upper third, thus rendering it imppossible to replace the bone. In another case of spontaneous dislocation of the knee, occurring in the same painless manner, the joint could not be replaced, and permanent deformity was left. After reduction in similar cases, a splint or a starched bandage should be worn for a considerable length of time, so as to give a chance for the ligaments of the joints to recover themselves. If there be a rheumatic tendency, it should be removed by suitable treatment; and if there be a paralytic condition of the muscles, electricity, the endermic applica-

tion or hypodermic injection of strychnine, and cold douches with friction, may be advantageously employed.

Congenital Dislocations are occasionally met with in the hip, shoulder, wrist, and jaw, and have of late years attracted the attention of Surgeons through the labors of Guérin, Smith, Chelius, Robert, and others. These dislocations are closely allied in cause and nature with other congenital deformities of the limbs, such as club-foot, &c. In them there is usually found arrested or imperfect development of some portions of the osseous articular apparatus. Whether this is original, thus causing the displacement of the bones, or consecutive upon disuse, occasioned by spasmodic action of one set of muscles or by paralysis of another, dependent on some irritation in the nervous centres, is scarcely worth inquiring here. In some cases it would appear as if faulty position of the fœtus in utero, or undue violence during birth, may have occasioned the displacement. These dislocations are probably incurable, as there is always congenital defect of structure in the articular ends of the bones, or of the socket into which they are received.

There is a peculiar form of dislocation which I have once, and only once, met with in a child, otherwise perfectly healthy, 12 years of age, and which had some resemblance to the congenital form. It was a dislocation of the head of the radius backwards, in consequence of want of development of the lower third of the ulna. In this case the radius was nearly two inches longer than the ulna. The want of development in the latter bone prevented the proper growth of the fore-arm; and the radius consequently, after having become slightly curved, became slowly, but completely, dislocated at its humeral end. All the movements of the bone, however, were perfect.

CHAPTER XXIII.

SPECIAL DISLOCATIONS.

DISLOCATIONS OF THE LOWER JAW.

Dislocations of the Lower Jaw are not common accidents. They occur more frequently in women than in men, and have been but very seldom met with at either extreme of life; but Nélaton and Malgaigne relate cases occurring in edentulous subjects of 68 and 72 years of age, and Sir A. Cooper has seen the accident in a child, occasioned by another boy thrusting an apple into its mouth. These dislocations are most frequently occasioned by spasmodic action of the depressor muscles of the jaw—by opening the mouth too wide, as in fits of laughing, of gaping, or in attempting to take too large a bite. Occasionally this accident has resulted from blows or kicks upon the chin when the mouth is open, or from the violent strain upon the part in tooth-drawing, or rather in digging out stumps with an elevator. The mechanism of the dislocation is simple. When the mouth is opened, the interarticular fibro-cartilage with the condyle glides forwards on to the articular eminence; if this movement be continued too far, and the external pterygoid muscle contract forcibly at the same time, the condyle slips forward over the articu-

lar eminence into the zygomatic fossa, the axis of the ramus being directed obliquely backwards, and the dislocations being thus complete. In this way both condyles may be displaced, or only one. Maisonneuve and Otto Weber, by producing dislocation on the dead body, have found that the condyle lies in front of the root of the zygoma. The coronoid process rarely reaches the malar bone, but usually lies below it, being completely surrounded by the tendon of the temporal muscle. From original observation, C. Heath confirms this view of the position of the coronoid process. The interarticular fibro-cartilage is attached to the condyle, and follows its movements. The capsular ligament is stretched, but not ruptured: the external lateral ligament is tense, and passes from behind forward instead of from before backward: the internal lateral and stylo-maxillary ligaments also undergo stretching, which is increased by raising the chin. The temporal muscles are stretched according to Maisonneuve, or partly torn according to Weber.

When the dislocation is **Bilateral**, as most frequently happens, both condyles being displaced from the glenoid cavities, the signs are as follows. The incisor teeth of the lower jaw are separated from those of the upper by a marked interval, varying from half an inch to an inch and a half; the mouth consequently cannot be closed, but is kept more or less widely open. Deglutition and speech are impaired, the labial consonants not being pronounced; there is dribbling of the saliva over the lower lip; the chin is lengthened, and the lower line of teeth advanced about half an inch beyond those of the upper jaw; the cheeks are flattened, and there is a depression in front of the meatus auditorius externus. There is also an oblong prominence in the temporal fossa between the eye and the ear. If the dislocation be left unreduced, the patient slowly regains some power of movement over the jaw; he gradually approximates the lips, and, after a length of time, may even be enabled to bring the lines of teeth into apposition, especially posteriorly.

In the **Unilateral** dislocation, where one condyle only is displaced, the axis of the lower jaw is directed towards the opposite to that on which the displacement exists; and the general signs are the same, but in a less marked degree, as those which are met with when both sides are dislocated. The hollow before the meatus on the injured side is, however, well marked, and serves to point out the seat and nature of the displacement, the diagnosis of which is not always readily made; indeed, R. W. Smith states that he has seen attempts at reduction applied to the uninjured side.

Sir A. Cooper has described a **Subluxation** of the jaw, most frequently met with in young and delicate women, in which, in consequence of the relaxation of the ligaments, the head of the bone appears to slip forwards upon the eminentia articularis, whenever the mouth is opened at all widely, as in gaping, laughing, &c. It may usually be ascertained by telling the patient to put out the tongue. The bone hitches, as it were, and prevents the mouth from being shut at once. Most commonly, the natural efforts of the patient are sufficient to return the head of the bone into the glenoid cavity with a cracking noise or even a loud snap.

The **Reduction** of a dislocated jaw is easily effected; it being only necessary to push the angle of the bone downwards and backwards, so as to disentangle the coronoid process from under the zygomatic arch, at the same time that the chin is raised by the Surgeon's fingers, in order that the temporal and pterygoid muscles may draw the head of the bone into its proper position. The reduction is best effected by the Surgeon

standing before the patient and applying his thumbs, well protected by a thick napkin, to the molar teeth on each side, and thus depressing the angle of the jaw forcibly, at the same time that he raises the chin by means of his fingers spread out and placed underneath it. The bone is then returned into its place with so forcible a snap that the thumbs may be severely bitten unless care be taken, or they be well protected. When one condyle only is luxated, the efforts at reduction should be applied to the injured side only. After the reduction, the four-tailed bandage should be applied, as in cases of fracture of the jaw; and for several days the patient must not be allowed to talk, or to eat any solid food, lest the displacement return, which it always has a great tendency to do. Very old dislocations of this bone may be reduced by the process just now described. Thus, Stromeyer replaced one at the end of thirty-five, Donovan one at the end of ninety-eight days, and Pollock one at the end of four months.

In the cases of *subluxation*, attention should be paid to the state of the general health. Tonics, more particularly iron, should be administered; good diet, the cold bath, and open-air exercise enjoined. If, as frequently happens, there be some tenderness about the temporo-maxillary articulation, a series of small blisters may be applied over it. It is of great importance to prevent the habit of recurrence of the dislocation. This may usually most conveniently be done by letting the patient wear a small silk cap fitted to the chin and attached by four elastic bands on the top of and behind the head, as in the case of a fractured jaw.

Congenital Dislocation of one Condyle of the Lower Jaw is a remarkable and rare condition, for an acquaintance with which we are chiefly indebted to R. W. Smith. In this condition there is a singular distortion of countenance. The osseous and muscular structures on the dislocated side are atrophied, and the teeth of the upper jaw project beyond those of the lower, contrary to what occurs in the accidental dislocation: the mouth can be closed, speech is perfect, and there is no dribbling of saliva. Congenital dislocation of both condyles has not yet been observed.

DISLOCATIONS OF THE UPPER LIMB.

Dislocations of the Clavicle.—When we look at the flat character of the sterno-clavicular articulation and the very small and shallow surface in the acromion upon which the outer end of the clavicle is received, and reflect on the violence to which the shoulder is frequently subjected, we might at first imagine that dislocations of the clavicle would be amongst the most frequent forms of injury in this region. But this is very far from being the case. They are, indeed, rarely met with in comparison to the frequency of fractures of this bone. This is owing to several causes: amongst these are the shortness and firmness of the ligaments by which the clavicle is attached to the sternum and acromion, and the fact that any force applied to the bone is usually received in a line that corresponds to its axis, thus causing it to be bent or broken rather than luxated. The mobility of the scapula, also, has a special tendency to prevent dislocations of the outer end of the clavicle, the two bones easily moving together. Were it not for these circumstances, the bone would frequently be thrown off the small flat articular surface of the acromion.

Dislocations of the clavicle can only be occasioned by violence applied

to the shoulder in such a direction, as to drive the bone inwards towards the mesial line, at the same time that the scapula is fixed.

Either the sternal or the acromial end of the clavicle may be dislocated, and the simultaneous displacement of both ends has been observed.

1. The **Sternal End of the Clavicle** may be luxated in a direction *forwards*, *backwards*, or *upwards*, being thrown before, behind, or above the sternum.

In the dislocation **Forwards**, the end of the bone can be felt in its new position, the point of the shoulder is approximated to the mesial line, and the depressions above and below the clavicle are strongly defined. It is occasioned by blows upon the shoulder, by bending this part forcibly backwards, or by violence applied to the elbow whilst the arm is raised from the side. In some cases it occurs spontaneously, as a secondary consequence of lateral curvature or rotation of the upper dorsal vertebræ.

This dislocation, which is amongst the most frequent to which the clavicle is subject, may readily be *reduced* by pushing the shoulder outwards and bending it backwards, while the elbow is brought in front of the mid-lateral line. The principal difficulty in the treatment consists in preventing the return of the displacement, owing to the shallowness of the articular surface upon which the clavicle lodges. With this view a pad and a figure-of-8 bandage must be firmly applied upon the displaced end of the bone, as in cases of fracture, but in dislocation the elbow should be more advanced than in fracture, and the hand brought over the front of the chest towards the opposite shoulder.

The dislocation **Upwards** is extremely rare. There are only eight cases on record. It has been well described by R. W. Smith. In it the shoulder falls in, the sternal end of the clavicle forms a prominent tumor in front of the trachea, the sterno-mastoid muscle has an arched outline, and the axis of the bone is directed upwards, forwards, and inwards, so that the interval between the clavicle and the first rib is very considerable. The trachea and œsophagus are compressed when the patient sits up or leans forwards. Smith found on dissection that the head of the bone lay above the sternum, and rested on the sterno-hyoid muscle and trachea, the ligaments of the joint being torn through, as was also the costo-clavicular ligament (Fig. 205). He observes that the reason of its rarity is that it can only be produced by force acting on the shoulder in a very unusual direction, viz., downwards, inwards, and probably backwards. The *Treatment* consists in placing a pad in the axilla, elevating the elbow, and bringing it well to the side. But I doubt if the bone, though replaced, can be maintained in a good position.

Fig. 205.—Position of Clavicle in Dislocation of Sternal End Upwards. (Smith.)

The dislocation **Backwards** is not of common occurrence: though, according to Nélaton, there are at least ten or a dozen cases on record. This luxation appears generally to have resulted from the point of the shoulder being driven upwards, or from the hand being violently drawn forwards. It has also been observed to result from the direct pressure of the clavicle backwards, as by the kick of a horse. In one case under my care, the clavicle was dislocated backwards at its sternal end by the wheel of a cab passing across the bone, and thus directly pressing it backwards, fracturing at the same time the second rib, and separating the first from its cartilage, which was attached to the clavicle by the unruptured costo-clavicular ligament, the traction on which by the dislocated clavicle had probably determined the separation of the cartilage from its rib. It has also occurred as a secondary consequence of curvature of the spine.

The *Signs* are those that usually attend a dislocation of the sternal end of the clavicle—shortening of the shoulder, and deformity about the upper part of the sternum; but besides these, a special train of symptoms is occasioned, by the pressure of the displaced bone upon the trachea, œsophagus, and vessels of the neck. Difficulty in breathing and swallowing, with congestion of the head giving rise even to a semi-comatose state, may be produced to such an extent as to require removal of the end of the bone, as happened in a case related by Sir A. Cooper, in which the Surgeon was obliged to saw off the dislocated end. In some cases, the end of the bone is thrown upwards as well as backwards; in others, it takes rather a downward direction. In one case only—that described in the preceding paragraph—have I had an opportunity of examining, after death, the condition of the limb in dislocation backwards of the sternal end of the clavicle. In this case, all the ligamentous structures around the end of the bone were torn through, with the exception of the costo-clavicular ligament, which had preserved its attachments unbroken, and had carried away the cartilage of the first rib in the direction of the displaced clavicle.

In the *Treatment* of this dislocation, it is easy to effect the reduction of the bone by making a fulcrum of the fist in the axilla, and then bringing the elbow well to the side, at the same time that an assistant puts his knee between the patient's shoulders and bends them back; but it is difficult to retain the bone in proper position. To fulfil this object, the figure-of-8 bandage tightly applied to the points of the shoulders, and crossed over a large pad placed in the middle of the back, will give the most efficient support to the part, the elbow being at the same time well fixed to the side and drawn back.

2. The dislocations of the **Outer End of the Clavicle**, or more correctly, the dislocations of the acromion from the clavicle, are more commonly met with than those just described. The most frequent accident of this description is that in which the bone is thrown **upon the Upper Surface of the Acromion**, or **upon the Anterior Part of the Spine of the Scapula**. In several cases of this accident which have presented themselves at University College Hospital, there has been no difficulty whatever in the diagnosis. The prominence formed by the displaced bone upon the upper surface of the acromion, the narrowing of the distance from the mesial line to the point of the shoulder, to the extent of from an inch to an inch and a half, the facility of the reduction of the dislocation, and the prominence of the clavicular portion of the trapezius muscle, indicate the nature of the accident (Fig 206). The *Treatment* of this injury is by no means satisfactory. Reduction may

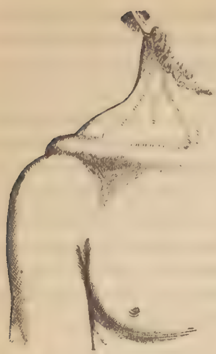


Fig. 206. — Dislocation of the Clavicle on the Acromion.

easily be effected by raising the shoulder, drawing it backwards, and carrying it outwards by placing a pad or the hand in the axilla and bringing the elbow well to the side. But, notwithstanding the facility of reduction, there is in many cases a great and, indeed, an unconquerable tendency to the return of the displacement. This is partly owing to the shallowness of the articular surface of the acromion, partly to the tension of the trapezius, by which the acromial end of the bone is drawn upwards and outwards, and in a great degree to the mobility of the shoulder. Reduction is best maintained by the application of an axillary pad, and the same method of treatment as in fracture of the clavicle (Fig. 158).

In every movement of the body or neck there will be found to be a tendency to rising upwards of the end of the dislocated bone, and in the majority of cases this will be insurmountable by any mechanical means that can be employed. It is best limited, if not obviated, by a pad and gutta-percha plate laid on the projecting clavicle, and strapped tightly down by a band passing parallel to the arm and under the flexed forearm, this being retained in position by being attached to a strap passed round the opposite axilla. If the displacement continue to be irremediable, a very useful arm will still be left, only somewhat limited in its upward movements.

The outer end of the clavicle has been dislocated **under the Acromion** by the application of direct violence to the end of the bone. This form of displacement is very rare; several instances have, however, been mentioned in the journals. The diagnosis is easy, simple digital examination pointing out the nature of the accident; and the treatment must be conducted in the same way as that of fractured clavicle.

The acromial end of the clavicle has been known to be displaced **underneath the Coracoid Process**. Here, also, simple examination and the clavicular bandage suffice for diagnosis and treatment.

The only instances of **Simultaneous dislocation of both ends of the Clavicle** with which I am acquainted have been reported by Richerand and Morel Lavallée.

Dislocation of the Scapula.—The **Lower Angle and Dorsal Border** of the scapula is occasionally the seat of a very remarkable kind of displacement, in consequence of which it projects at a considerable angle from the trunk, giving a winged appearance to the back. The cause of this peculiar displacement is obscure: by some it is considered to be dependent upon the bone slipping away from under the posterior edge of the latissimus dorsi muscle; by others, and apparently with more reason, it is regarded as owing to paralysis of the serratus magnus. Whether this be dependent upon some morbid condition of the muscle itself, as Jacob supposes, or on a paralysed state of the long thoracic nerve, as Nélaton thinks, can scarcely be determined. In such cases as these, I have seen some benefit derived from the endermic application of strychnine on a blistered surface, and afterwards support by means of a properly constructed apparatus.

Dislocations of the Shoulder-Joint occur far more frequently than those of any other articulation. Their pathology and treatment have

been so clearly elucidated by Sir A. Cooper, that there is little left for subsequent writers but to follow the descriptions given by that great Surgeon; though several of the modern French Surgeons, especially Velpeau, Malgaigne, and Goyrand, have thrown some new light on the subject. The reason of the frequency of these dislocations is to be found in the shallowness of the glenoid cavity, the large size and rounded shape of the head of the humerus, and the weakness of the ligaments; but, above all, in the extent and force of the movements to which the joint is subjected. These displacements indeed would be much more frequent than they even are, were it not for the protection afforded to the joint by the osseous and ligamentous arch formed by the coracoid process and acromion with their ligaments, the great strength of the capsular muscles and their close connection with the joint, and the support given by the tension of the long head of the biceps over its weakest part; but the principal obstacle to dislocation is the mobility of the scapula, enabling all movements communicated to the hand and arm to react upon that bone.

The **Signs** of dislocation of the shoulder-joint are sufficiently obvious, varying, however, according to the nature of the injury. In all cases there are six common signs, viz.: 1, a flattening of the shoulder; 2, a hollow under the acromion; 3, an apparent projection of this process, with hollow tension of the deltoid; 4, the presence of the head of the bone in an abnormal situation; 5, rigidity; and 6, pain about the shoulder.

The shoulder-joint is susceptible of *four* dislocations. Of these, according to Sir A. Cooper, three are complete and the fourth partial. I think, however, that on examination it will be found that the so-called *partial* dislocation is in reality a complete one. The directions in which

DISLOCATIONS OF THE HEAD OF THE HUMERUS.

Fig. 207.—Subcoracoid. Fig. 208.—Subclavicular. Fig. 209.—Subspinous. Fig. 210.—Subglenoid.

the head of the humerus may be thrown are—1, *inwards and slightly downwards* beneath the coracoid process—*Subcoracoid* (Fig. 207); 2, *forwards and inwards* beneath the clavicle—*Subclavicular* (Fig. 208); 3, *backwards and downwards* under the spine of the scapula—*Subspinous* (Fig 209); 4, *downwards and slightly inwards* under the glenoid cavity—*Subglenoid* (Fig. 210). Thus three dislocations are more or less inwards, one only being backwards or inwards.

1. **Subcoracoid Dislocation.**—In the case of *incomplete* dislocation reported by Sir A. Cooper, the head of the bone was found to be thrown

out of the glenoid cavity, lying under the coracoid process upon the anterior part of the neck of the scapula (Fig. 207); the capsular muscles were not torn, but the long head of the biceps had been ruptured. The description given by Sir A. Cooper, and the illustrative plate in his work on *Dislocations*, appear to point to a form of injury of the shoulder-joint which has of late years been specially described by the French surgeons as a variety of the dislocation downwards; that form of displacement, indeed, which by Boyer has been described as the dislocation "inwards," by Malgaigne, as the "subcoracoid" luxation, and by Velpeau as the "subscapular" dislocation; in which the head of the humerus is placed in front of the neck of the scapula, and underneath the subscapular muscle. In this dislocation, the head of the bone, instead of being thrown, as in the subglenoid, downwards and slightly inwards, is thrown inwards either directly or slightly downwards as well. Why Sir A. Cooper describes this as a *partial* dislocation, I do not understand; for not only was there rupture of the capsule, and of the long tendon of the biceps, but the woodcut at page 401 of the last edition of his work shows clearly that the head of the bone had formed a new articular cavity for itself in the subscapular fossa, being apparently completely thrown out of the glenoid cavity.

There is here less deformity than in the other luxations, the acromion not forming so distinct a projection (Fig. 211). The limb is usually somewhat lengthened, but at times is actually shortened, the elbow being generally carried backwards and always slightly away from the side; the head of the bone is placed deeply in the upper and inner part of the axilla, and cannot always be very distinctly felt, owing to its being thickly covered with soft parts, by the coraco-brachialis as well as by the pectorals; rotation of the arm and elevation of the elbow being usually required in order that it may be detected. There may be pain from the pressure of the head of the bone on the nerves or from stretching, and if the vein be pressed on, œdema of the whole limb will occur.

Fig. 211.—Subcoracoid Dislocation of Humerus.

2. In the dislocation **Forwards**, or the **Subclavicular** (Fig. 208), the head of the bone is thrown on the inner side of the coracoid process, lying upon the second and third ribs under the pectoral muscles, and immediately below the clavicle. This dislocation is merely an increased degree of the preceding one, the head of the bone, which at first lies under the coracoid process, being readily drawn inwards, so as to be placed to the inner side of this process under the clavicle. In these cases the capsular muscles are much stretched or torn. In a case recorded by Curling, the infraspinatus and subscapularis muscles were torn away from the tubercles of the humerus, and the teres minor partially lacerated; the capsule being completely separated from the neck of the bone, which pressed forcibly upon the axillary vessels and nerves. In three cases which I have had an opportunity of dissecting and examining after death, the great tubercle was torn away from the head of the bone, with much laceration of the capsule and extensive extravasation, but the external rotator muscles were not ruptured in two instances; whilst in the third the supraspinatus, the infraspinatus, and the teres minor, were all torn

across near the insertions into the humerus. In fact, in these cases it appears to be a question of strength between muscle and bone; either the muscles are torn across, or the great tubercle, into which they are inserted, is torn away from the shaft of the bone, leaving its attached muscles unruptured.

In this dislocation, the head of the humerus can be felt and seen under the pectoral muscles beneath the clavicle; the arm is shortened, the axis of the limb being directed towards its head, and the elbow is a good deal separated from the side and thrown back.

3. In the dislocation **Backwards**, or the **Subspinous** (Fig. 209), the head of the humerus lies behind the glenoid cavity, and below the spine of the scapula, between the infraspinatus and teres minor muscles. Key found the tendon of the subscapularis torn across, together with the internal portion of the capsular ligament; the supraspinatus and the long head of the biceps being stretched, but not ruptured.

When the head of the bone is dislocated below the spine of the scapula, it can be felt and seen there, more especially when the arm is rotated. The axis of the limb is altered, being directed backwards nearly horizontally; the elbow is raised from the side, to which it cannot be approximated, and is carried forwards and somewhat downwards.

4. In the dislocation **Downwards**, or the **Subglenoid** (Fig. 210), the head of the bone lies in the axilla, resting against the inferior costa of the scapula below the glenoid cavity, and lodged between the subscapular muscle and the long portion of the triceps. In it the tendon of the subscapular muscle is commonly torn near its insertion into the lesser tubercle of the humerus, and the capsular ligament is largely lacerated. The supraspinatus muscle may also be torn through, or a portion of the great tubercle of the humerus detached, and the rest of the capsular muscles put greatly on the stretch. The axillary artery and plexus of nerves are compressed and stretched by the dislocated head of the bone, so that a severe numb pain is commonly experienced in the hand and arm. The compression of the artery is so great, that the circulation through the limb may be completely arrested. This I saw remarkably illustrated in a case of dislocation downwards of the head of the humerus, with a severe lacerated wound of the fore-arm, dividing the radial and ulnar arteries. So long as the dislocation remained unreduced, no hæmorrhage took place; but when the head of the bone was replaced, the injured arteries bled freely.

Fig. 212.—Subglenoid Dislocation.

The head of the bone can usually be readily felt in the axilla, at its anterior and upper part, the arm is lengthened to the extent of about an inch, the fore-arm is usually somewhat bent, and the fingers are often numbed, in consequence of the pressure of the head of the bone on the axillary plexus. The elbow is separated from the trunk and carried somewhat backwards, but can be approximated to the side. If the head of the bone cannot be felt in the axilla, its presence there may be ascertained, as Cooper directs, by raising the elbow, when it at once becomes perceptible.

In a case which occurred to Cleland of Galway, the arm was thrown up so as to reach above the patient's head. The patient was lame and

used crutches; and Cleland supposes that one of the crutches, having slipped, acted as a fulcrum in such a way as to cause the weight of the body in falling to overcome the tendency of the latissimus dorsi and pectoralis major muscles to draw the arm towards the side. Reduction was readily effected.

The dislocation of the humerus to which the term **Partial** is usually applied, is that which was described by Soden in 1841, in which the long tendon of the biceps is displaced from its groove or ruptured, and the head of the bone is thrown upwards and forwards under the coracoid process, but not out of the glenoid cavity. It is to this form of displacement also that Callaway seems disposed to confine the term *partial*. Le Gros Clarke has recently published an account of a case in which there was partial dislocation of the head of the humerus behind and below the acromion.

In this partial dislocation the *signs* do not appear to be very evident. In Soden's case there was slight flattening of the outer and posterior parts of the joint, and the head of the bone appeared to be drawn higher up in the glenoid cavity than usual. There was great pain induced by any movement of the biceps muscle; and, on attempting any overhand motions, the head of the bone became locked by the acromion. A peculiar partial dislocation of the humerus forward, dependent on paralysis of the deltoid, will be discussed in the Chapter on Traumatic Paralysis.

Causes.—Dislocations of the shoulder-joint are in almost all cases the result of falls upon the hand or elbow: the particular variety of dislocation depending upon the direction of the shock communicated to the arm, and the position of the limb at the time of receiving it. On this account we almost invariably find the displacement in a direction inwards and downwards. When a person saves himself in falling with his arms widely stretched out, the head of the bone is driven with all the force of a long lever against the lower and inner portion of the capsule, which, being ruptured, in this its weakest part, allows the bone to be thrown upon or to the inside of the inferior costa of the scapula, and thus into the axilla. When the patient falls upon his elbow, the inner part of the joint is still acted on; but, the leverage not being so great, the head of the bone is thrown upwards or forwards under the clavicle. This dislocation is also often the result of direct violence applied to the shoulder.

The dislocation backwards can only take place if the arm receive the shock at the time when it is stretched across the chest. As this is an unusual position for any injury to be received in, this dislocation is proportionately rare. An obstacle to this displacement may also be found in the great strength of the outer portion of the capsule of the joint, as compared with the inner.

Relative Frequency.—Sir A. Cooper states that the dislocation "into the axilla" is a most frequent form of accident. This opinion is confirmed by that of most English Surgeons. But Malgaigne, and more recently Flower, have expressed the opinion that the subcoracoid is the most common form of this accident. Flower, who has very ably investigated this subject, finds that of forty-one specimens in the different London Museums, thirty-one are undoubtedly *subcoracoid*, and that, of fifty recent cases of which he has cognisance, forty-four were of this form. Next in order of frequency comes the *subglenoid*, and then the *subclavicular*, which is rare. I believe that the subclavicular is, as it were, an exaggerated degree of the subcoracoid; the continuance of the same force, whether mechanical or muscular, which had thrown or drawn the head of the bone to the inner side of the coracoid process, carrying it

upwards and inwards under the centre of the clavicle. The displacement of the head of the bone under the spine of the scapula is so rare that Sir A. Cooper met with two cases only of it; several cases have occurred at University College Hospital, which were reduced without difficulty.

Diagnosis.—Dislocations of the humerus may readily be diagnosed from *fractures of the anatomical and surgical neck* of the bone, by the existence of the signs which are common to all luxations, and by the absence of crepitus. In fractures in this situation, also, the glenoid cavity always continues to be occupied by the head of the bone. The existence of crepitus, and of slight shortening but little alteration in the axis of the limb, and no correspondence between this and the position of its head, are additional signs of value in establishing the diagnosis. The nature of the accident that occasions the injury is often an important element in the diagnosis. Fractures of the upper end of the humerus can only occur from direct violence applied to the shoulder. Dislocations, on the other hand, are almost invariably the result of indirect violence applied to the hand or elbow. Hence the injury resulting from a fall or blow on the shoulder itself is almost always a fracture; that from a fall on the hand or blow on the elbow a dislocation of the humerus. *Paralysis of the deltoid from a blow or from injury of the circumflex nerve* may simulate a dislocation, the shoulder being flattened and the acromion projecting: but here the mobility of the joint, and the presence of the head of the bone in the glenoid cavity, establish the absence of dislocation.

The **Reduction** of a dislocated humerus may be conducted on three different plans:—*by the heel in the axilla; by the knee;* or *by drawing the arm upwards.* Whichever plan is adopted the patient should, if strong,

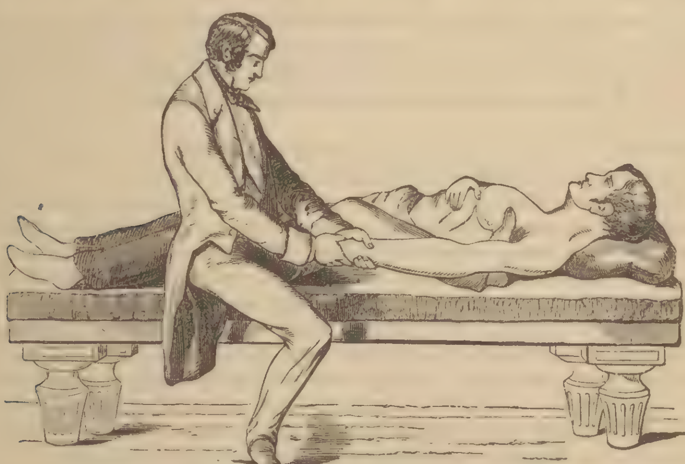


Fig. 213.—Reduction of Dislocated Shoulder-joint, by the Heel in the Axilla.

be put under the influence of chloroform; when his muscles are paralysed by this agent but little force is required to effect the reduction, the Surgeon's unaided strength usually sufficing for this purpose. If more power, however, should be required than he can exercise, extension may be made by assistants drawing upon a towel properly fixed round the lower end of the humerus, or else by the pulleys attached to the same part of the limb.

1. The reduction of the dislocation *by the heel in the axilla*, is certainly the easiest procedure in ordinary cases. In adopting this plan, the patient is laid upon his back upon a low bed or couch, or even on the ground; the Surgeon, seating himself upon the edge of this on the same side as the dislocated arm, takes the limb by the wrist, and, fixing one foot firmly upon the ground, places the other, covered merely with the stocking, well up into the axilla, so that the heel may press against the lower border of the scapula, and the foot act upon the humerus (Fig. 213). He then draws the limb steadily downwards, and, when it is disengaged to a sufficient extent, brings the hand across the front of the patient, the foot acting as a fulcrum, by which the head of the bone may be reduced by being pushed upwards and outwards. This mode of reduction is especially serviceable in ordinary dislocations into the axilla, and in those under the clavicle. In the latter, however, it will be necessary to draw the arm more obliquely downwards and backwards, and to press the foot somewhat forwards upon the head of the bone, after it has been disengaged by being brought below the coracoid process.

2. The reduction *by the knee in the axilla* is precisely the same in principle as the last, though not by any means so good a plan; the knee being too large, and not following the movements of the humerus so readily as the foot. In effecting the reduction by this means, the patient is seated on a chair; and the Surgeon, standing by his side and resting one foot upon the chair, places his knee in the patient's axilla. He then seizes the patient's arm above the elbow with his right hand, and, steadying the acromion with his left, draws the limb well away from the body and then depresses it across the knee: the head of the bone is thus reduced.

3. In some cases reduction is easily effected by laying the patient on his back, when the Surgeon, sitting behind him, *raises the arm perpendicularly* by the side of the head, at the same time fixing the acromion. The head of the bone is thus brought directly upwards into the glenoid cavity.

If the patient be very muscular, or the dislocation of old standing, it may be necessary to have recourse to the *pulleys* in order to effect reduction. In applying these the scapula must be firmly fixed, the counter-extension being made by passing the patient's arm through a slit in the middle of a jack towel, which should be fixed firmly to a hook or staple in the wall. The extending force may then be applied immediately above the elbow; and traction being made slowly and steadily in the direction of the axis of the limb. The head of the bone should be directed to the glenoid cavity by the pressure of the Surgeon's hands, so soon as it has come on a level with it. In this way dislocations of the humerus of many weeks' or even months' standing have been successfully reduced; but in employing these powerful means, especially under the influence of chloroform, the Surgeon should always bear in mind that, unless care be taken, serious mischief, even laceration of the axillary artery, may result (pp. 465, 466, 481, 482).

After dislocation of the humerus has been reduced, the limb should be firmly fixed to the side for at least two weeks. It may then be put in a sling for another fortnight; and, at the end of a month, passive motion, with friction, may be employed. If inflammation occur about the joint, recourse may be had to leeches and evaporating lotions.

After reduction, there is a tendency for the head of the bone to be drawn upwards and outwards under and against the acromion, owing

evidently to the deltoid and coraco-brachialis muscles not being counterbalanced in their actions by those that have been separated from the head of the bone.

Compound Dislocation of the Head of the Humerus is a rare accident. I have, however, seen two cases of it, and in two directions: downwards—*Subglenoid*, and inwards—*Subcoracoid*. In both cases reduction was effected, and the patients did well. In it, even though the injury be extensive, it is better not to amputate if the axillary vessels and nerves be uninjured. The limb may be saved by reducing the bone at once; after this the wound should then be closed and dressed lightly, and kept cool by constant irrigation. If the axillary artery be ruptured, either completely or through its inner and middle coats, obstruction to the arterial circulation of the arm will ensue, and amputation must be performed through the articulation.

Complications.—*A Simple Dislocation of the Head of the Humerus, with Rupture of the Axillary Artery* and the formation of a diffused axillary aneurism, is serious but fortunately rare. In a case of this kind, R. Adams, after reducing the dislocation, ligatured the subclavian artery, the patient recovering: and this would be the proper practice to pursue in similar cases.

A very serious accident, and apparently difficult to treat, consists in the complication of a *Dislocation of the Humerus with Fracture through the Epiphysis* of the displaced bone. A case of this kind, to which I was called, is described at page 467.

When the dislocation is complicated with a *Fracture of the Shaft of the Bone*, it should be reduced at once by putting the fracture up very firmly, and then attempting the reduction by one of the usual methods. In the cases to which I have already referred (p. 467), I succeeded without difficulty by means of the heel in the axilla. The fracture must then be treated by lateral splints.

Congenital Dislocations of the Shoulder-joint have of late years attracted attention. R. W. Smith has ascertained, by *post-mortem* examination, the existence of two varieties of this condition—the *Subcoracoid* and *Subacromial* luxations. In these there is wasting of the muscles of the shoulder and arm, the motions of which are extremely limited, whilst those of the scapula are preternaturally great. The condition of the bones is also remarkable. In a case of congenital subacromial luxation of both shoulders, there was no trace of a glenoid cavity; but a well-formed socket existed on the outer side of the neck of the scapula, receiving the head of the humerus, which was small and distorted. These dislocations, though existing from birth, usually become more marked as age advances, but are necessarily irremediable, in consequence of the malformation of the osseous structures and the wasting of the muscles.

Old Unreduced Dislocations of the Head of the Humerus are not unfrequently met with. In the majority of these cases there is a considerable amount of pain and immobility about the shoulder at first; but after a time the head of the humerus forms a new bed for itself, and the movements of the arm become freer and less painful, so that eventually a limb useful for all except the overhead movements will result.

In cases of old dislocation of the head of the humerus, the question as to the advisability of attempting reduction always presents itself to the Surgeon. As a general rule this should always be attempted under chloroform, in accordance with the principles laid down at p. 464, if only a few weeks have elapsed from the time of the accident, and then it will

usually be attended with success. Reduction has been effected in many cases at much later periods than this; by Brodhurst, after twenty-five weeks had elapsed; by Smith (U. S.), after six, seven, eight, nine and ten months; by Malgaigne, after eight months; by Caron du Pillard, after six months; and by Sédillot, after a year. By the use of the subcutaneous division of muscles, &c., Dieffenbach is said to have succeeded in reducing a dislocation of the shoulder after it had existed two years. In many cases, however, at a much earlier period than these, the Surgeon will fail, notwithstanding the most persevering attempts at reduction; and in others again certain accidents have occurred, which every Surgeon should bear in mind, so as to render him cautious in his proceedings.

The *Accidents* that have occurred in attempts at reducing old-standing dislocations of the head of the humerus are such as may arise either from the employment of an undue amount of force, from the separation of the head of the humerus from the adhesions that it has contracted in its new situation, or from pathological changes in the limb itself. Among the first are laceration and bruising of the skin, subcutaneous areolar tissue, and muscles, with extravasation of blood: amongst the latter are fracture of the humerus, laceration of the axillary vessels and nerves, and avulsion of the limb.

Fracture of the humerus has occurred in the practice of many Surgeons of eminence. It has happened to Petit, Pott, Larrey, Bérard, Denonvilliers, and others. The surgical neck of the bone appears to have usually given way; and the accident has not occurred so much from forcible extension, as in carrying the arm across the chest so as to tilt the head of the bone into its place, when the shaft becomes exposed to fracture by pressure in a transverse direction. Such an accident necessarily prevents all further attempt at reduction.

Fracture of the ribs, by the pressure exercised against the wall of the chest, is supposed to have occurred in some cases.

The *extravasation* of a large quantity of blood into the areolar tissue of the axilla has occasionally occurred, without any evidence of the rupture of one of the main vessels. In these cases the swelling has gradually subsided under the employment of ordinary treatment, by rest and evaporating lotions.

More serious by far than this is the *rupture of one of the large blood-vessels* in the axilla. This may either happen from the pressure of the Surgeon's heel, as in a case reported by Hamilton, in which an attempt was made to reduce a dislocation of old standing by this means; the Surgeon unfortunately forgetting to remove his boot, and thus contusing and lacerating the artery. Or it may occur from the humerus having become adherent to the vessel, and lacerating this when torn away. The instances on record of laceration of the axillary artery, and the consequent formation of a diffuse *traumatic aneurism* in the axilla, in the reduction of old dislocations, are so numerous—there being at least twelve cases in the records of surgery—as to act as a warning to the Surgeon not to employ too much force.

In the great majority of these cases—in at least ten out of the twelve—the diffused traumatic aneurism appeared immediately after the employment of forcible and long-continued extension. In the remaining two instances, the aneurismal tumor did not appear until after the lapse of some time. In Dupuytren's case a woman, sixty years of age, had a dislocation into the axilla of six weeks' standing reduced. Two or three months after this, a tumor appeared in the armpit. This was mistaken for an abscess, and opened; arterial hæmorrhage ensued, and the patient

died on the eighth day, from secondary bleeding. In Nélaton's case the patient, also an old woman, had a subglenoid dislocation which was easily reduced. But an aneurism appeared in the axilla, which, three months after the reduction, compelled that distinguished Surgeon to tie the subclavian. Both these aneurisms were probably circumscribed.

Dupuytren's case was not the only one in which the fatal mistake was committed of opening the aneurism in the axilla—the same was done by Pelletan, who mistook the tumor for an emphysema; the result being of necessity fatal. In cases reported by Verduc, Petit, Platner, and Leudet, the aneurism was allowed to run its course unchecked by efficient surgical treatment, and in every instance proved fatal by the sac giving way, and secondary hæmorrhage ensuing. Sir C. Bell records a case that occurred at the Newcastle Infirmary, in which the pectoral muscles as well as the artery were torn, and immediately amputation became necessary. In four cases the subclavian artery had been ligatured. All these happened in America; two to Gibson, one to Blackman of Cincinnati, and one to Warren. Three of them proved fatal by secondary hæmorrhage, Warren's being the only one in which recovery took place.

What *Treatment* should be adopted in this distressing accident? If the aneurism be left to itself, or be treated by inefficient means, it must necessarily prove fatal by its rupture or sloughing and secondary hæmorrhage. The ligature of the subclavian is not very promising, as a fatal result occurred in three out of the four cases in which it has been tried for diffuse aneurism, Nélaton's case having been circumscribed. In these circumstances, it appears to me that it would be wiser to apply to these cases the usual principle of treatment that is adopted in cases of diffused axillary aneurism from other causes; viz., to compress the subclavian, lay open the sac, turn out coagula, and tie the torn artery at the seat of injury.

In one case, the dislocation being of twenty days' standing, and the patient a female 26 years old, Froriep states that reduction was followed by sudden and extensive tumefaction of the axilla, syncope and death in an hour and a half. A *post-mortem* examination disclosed *laceration of the axillary vein*. No mention is made of any internal injury to account for death.

Injury to the *axillary nerves* during reduction leading to paralysis of the arm has also been described. A case of this kind is mentioned by Billroth as having occurred in a patient under his care at Zurich. The dislocation was of nine months' standing, and had been attended with partial paralysis of the arm and some muscular atrophy. The reduction was followed by total paralysis, which Billroth attributes to laceration of the axillary nerves in consequence of their having become adherent to the bone.

Besides these accidents, other evil consequences have occasionally followed prolonged attempts at reducing old dislocations of the humerus, such as sudden death from *syncope*, and *exhaustion*. Guérin's remarkable case of *avulsion of the limb* at the elbow in a woman 63 years of age, in an attempt to restore a dislocated humerus three months after the luxation had occurred, is an instance of an accident that is as yet unique in the records of surgery. In this case no undue amount of force seems to have been used, but the tissues of the limb had become softened and porous—partly probably from disease, partly from senile changes.

In the event of the Surgeon being unsuccessful in his attempts at re-

duction, he must endeavor, by means of frictions and passive motion, to restore, as far as practicable, the utility of the limb. In some of these cases of old reduced dislocation, I have succeeded in very materially improving its condition by putting the patient under the influence of chloroform, and moving the limb freely to and fro so as to loosen, stretch, and break up the adhesions about the head of the bone; and it is in this way that attempts at reduction, even though unsuccessful in replacing the head of the bone, are often of great use in improving the mobility of the limb.

In cases of old standing, where symptoms of pressure on the large vessels and nerves are present, and where there is danger of their being injured in the attempt at reduction, Billroth recommends excision of the head of the bone. This has been done successfully by Langenbeck in a case of paralysis from pressure.

Dislocations of the Elbow are by no means unfrequent accidents; and, as they are often occasioned by direct violence, in consequence of which much swelling speedily sets in, their signs are frequently obscured, and the diagnosis is rendered proportionately difficult; more especially when the dislocation happens to be complicated with fracture of the articular ends of the bones. In these cases, indeed, it is only by an accurate acquaintance with the normal relations of the osseous points, and by a comparison between those of opposite sides, that the Surgeon can detect the true nature of the injury.

The **Varieties** of dislocation of the elbow-joint are very numerous, either both bones of the fore-arm or only one being implicated.

1. **Both Bones.**—The most common dislocation is that in which both bones are thrown *Backwards*, with or without fracture of the coronoid process. This injury is readily recognised by the projection backwards of the olecranon, carrying with it the tendon of the triceps. The articular end of the humerus also can be felt projecting in front of the elbow. When the coronoid process is not broken off, it is fixed against the posterior surface of the humerus, the fore-arm being immovably placed in its new position. When this process is fractured, there is great mobility about the joint, and crepitation may be felt as the arm is drawn forwards.

Dislocation of both bones **Forwards** can scarcely occur without fracture of the olecranon. Rare as this accident must be, there are at least five cases on record by Colston, Lana, Delpech, Canton, Forbes of Philadelphia, and Date, in which the bones have been so displaced without this process being broken. In this injury the elongation of the fore-arm, the projection of the condyles of the humerus, the presence of the sigmoid notch in front of the arm and the depression of the posterior surface of this bone, render the diagnosis sufficiently easy. In one case at University College Hospital, the injury was produced by the patient, a man 20 years of age, slipping on the pavement and falling on his elbow. In this instance the elbow was much bent; it could be brought to a right angle, and straightened considerably. The fore-arm was three-quarters of an inch longer than its fellow. The condyles of the humerus were on a level with the olecranon; the tendon of the triceps was very tight, and the sigmoid notch could be plainly felt on the fore part of the arm. The head of the radius could also be felt in front of the humerus. In the case recorded in the *Lancet*, 1872, by Mr. Date of Crewkerne, the dislocation was forwards and outwards, so that the head of the radius lay outside the external condyle. At the same time, the epiphysis at the inner condyle was separated. When the olecranon is broken off,

there is elongation of the fore-arm and great mobility, but the detached fragment can be felt behind the humerus.

The **Lateral** dislocation of the bones of the fore-arm is almost invariably incomplete; either the head of the radius hitching against the internal condyle, or the ulna coming into contact with the external one. Complete lateral dislocation of the bones of the fore-arm is excessively rare: the only instance with which I am acquainted is a luxation outwards, reported by Nélaton, of which he has given a woodcut.

The ulna or radius alone may be displaced; and in some cases, both are dislocated, but in opposite directions.

2. **Ulna.**—The only dislocation to which the ulna alone is subject is that in a direction **Backwards.** Although this displacement may occur in an uncomplicated form, it is more frequently associated with more or less dislocation of the head of the radius. When it occurs, it may be recognised by the projection of the olecranon backwards, and by the head of the radius being felt in its normal situation, or nearly so, during the movements of pronation and supination. In some extremely rare cases the coronoid process is fractured at the same time, causing ready disappearance and recurrence of the dislocation, with crepitus.

3. **Radius.**—The radius alone may be dislocated *forwards, backwards*, or *outwards*. The dislocation **Forwards** is certainly the most common. In the many instances of it that I have seen, it has resulted from a fall on the palm of the hand, by which the lower end of the radius is driven backwards, while the upper end is tilted forwards with the whole force of the leverage of the bone, and in this way, rupturing the annular ligament, is thrown against the external condyle. The signs of this displacement are the following. The fore-arm is slightly flexed, and in a mid state between pronation and supination; any attempt at completing the latter position occasions great pain, as does also the endeavor to straighten

Fig. 214.—Dislocation of the Radius forwards: Limit of Power of Bending the Arm.

Fig. 215.—Dislocation of the Radius forwards: Deformity of Outer Side of the Arm when Extended.

the arm. The elbow can only be bent at an obtuse angle, in consequence of the head of the radius being suddenly brought up against the lower end of the humerus, against which it strikes with a sudden shock (Figs. 214, 216). On rotating the radius much pain is experienced, and the head of the bone can be felt to roll on the fore part of the humerus, the

external condyles of which project unnaturally. The hand and arm can be fully pronated, but cannot be supinated more than half way. The whole of the outer side of the arm is deformed, being carried somewhat

Fig. 216.—Position of the Bones in an old Unreduced Dislocation of the Radius forwards.

upwards (Fig. 215). The rupture of the annular ligament in this dislocation makes it very difficult to keep the head of the radius properly fixed, so as to prevent a recurrence of the displacement

In some cases, and indeed not unfrequently, there is **incomplete dislocation of the radius forwards**, arising either from falls upon the hand, or from violent twists of the fore-arm. In these we have the preceding signs, though less marked. The most characteristic symptom, however, is the patient's inability to flex the fore-arm upon the arm. This he can never do to a greater extent than to bring the elbow to a right angle (Fig. 214). On being told to touch the tip of his shoulder with his fore-finger, he will find it impossible to do so.

The dislocation of the radius **Backwards** is extremely rare; it may always be recognised by the head of that bone being felt subcutaneously behind the external condyle; the movements of the elbow, and of the radius especially, being at the same time very limited and painful.

Dislocation of the radius **Outwards** is of more frequent occurrence than the last injury, the head of the bone being thrown on the outer side of the external condyle, where it is felt under the skin, rolling as the hand is moved. The natural motions of the joints are of course greatly interfered with.

The radius and ulna are sometimes displaced in **Opposite Directions**, the ulna being thrown *backwards*, and the radius *forwards*. This injury, of which I have seen two instances at the hospital, usually results from heavy falls upon the hand, with a wrench of the limb at the same time, as when a person is thrown out of a carriage and lights upon his hands, in consequence of which the bones are twisted and displaced in opposite directions. The deformity is of course great, but is readily recognised by the combination of the characters of the two forms of displacement, provided an examination be made before the swelling has come on, which rapidly sets in.

Complications.—Dislocations of the elbow-joint are very frequently complicated with fracture of one or other condyle of the humerus, of the olecranon, and—as we have already seen in displacement of the ulna, and more rarely—of the coronoid process. In these complicated injuries an exact diagnosis is often extremely difficult, owing to the laxity and mobility of the parts, and to the great tumefaction that accompanies accidents of this description. It is in these cases that a good knowledge of the relative bearing of the different osseous points, aided by a comparative examination of the opposite limb, will alone enable the Surgeon to effect a proper diagnosis of the nature of the injury.

The mode of **Reduction** in dislocations of the elbow-joint varies according as the ulna is displaced or not. When the ulna is dislocated,

in whatever direction it may be thrown, and whether the radius be displaced at the same time or not, the great obstacle to reduction is the hitching of the processes of the bone against the articular end of the humerus. If either the olecranon or coronoid process be fractured, this entanglement cannot take place, and the joint then readily slips into its position, though it is very difficult to maintain it there. The reduction of the displaced ulna, when uncomplicated by fracture, may always be effected, as Sir A. Cooper has recommended, by bending the arm over the knee. The patient being seated on a chair, the Surgeon rests one foot upon the seat, and, placing the knee in the bend of the injured elbow, grasps the fore-arm with both hands (Fig. 217); fixing the arm, he presses the knee firmly against the inner aspect of the fore-arm, so as to disengage the ulna from the lower end of the humerus, and at the same time he bends or pushes the fore-arm into proper position, into which, indeed, it has a tendency to return by the action of its own muscles, so soon as the opposing osseous surfaces are separated.

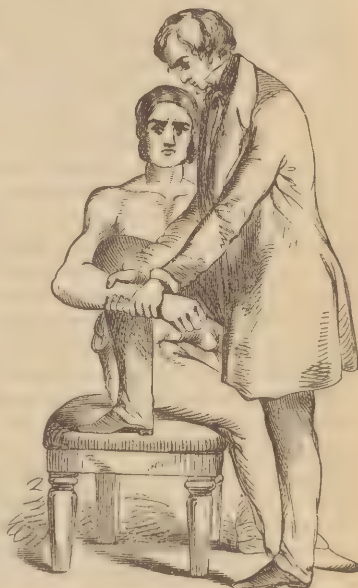


Fig. 217.—Dislocation of the Ulna: Reduction.

In dislocations of the radius, this movement across the knee is not necessary. All that is required is to fix the upper arm, and then, employing extension from the wrist, to straighten the arm well; when, by bending the elbow at right angles, the head of the radius may be pressed into a proper position.

After reduction has been effected, the limb should be firmly put up in lateral angular splints, the hand being kept semi-prone. If the radius have been displaced, a pad should be applied over its head, so as to prevent a return of the displacement, which is very apt to occur when the orbicular ligament is torn. In the case of dislocation of the radius *forwards*, however, reduction is best maintained by placing the arm in the extended position, and applying a straight splint, well padded, along the palmar aspect of the limb. The inflammation which usually results must be combated by the free application of leeches and of evaporating lotions. When this has subsided, passive motion may be commenced, and frictions and douches employed, so as to remove the stiffness that is apt to be left about the joint.

In those cases in which the dislocation is complicated with fracture of some part of the articular ends, and in which the diagnosis of the precise nature of the injury, owing to the swelling or other causes, has not been very clearly made out, the joint should be placed in as good a position as possible, by a process of traction, flexion, and moulding, so as to bring the osseous points into proper bearing with one another; the angular splints must then be applied and local antiphlogistic treatment employed. At the end of a month or five weeks passive motion may be commenced, lest permanent rigidity come on, which is very apt to supervene.

Compound Dislocations of the Elbow are always very serious injuries. In their treatment, the Surgeon will usually have to decide between resection of the articular ends of the displaced bones and amputation of the arm. He will be guided in his course by the amount of mischief done to the soft parts. If these be simply lacerated over the posterior aspect of the joint—the dislocation, when compound, being almost invariably backwards—the wound may be enlarged, and the articular ends removed. Should the soft structures be extensively contused and torn, the brachial artery or the median nerve injured, and the bones fractured as well as dislocated, amputation will be the safer course. In determining on the line of practice, however, the Surgeon will be guided by the considerations stated at p. 418, in reference to compound fracture of this joint. In some instances recovery has taken place with a very useful limb, even after severe compound dislocation of the elbow-joint, complicated with rupture of the brachial artery.

Old-standing Dislocations of the Elbow are reduced with much difficulty in all cases in which the ulna is completely displaced; this is owing rather to the interlocking of the irregular articular surfaces and to the formation of adhesions in the torn capsule and around the displaced bones, than to muscular contraction. The tendon of the triceps, and even that of the biceps, has been divided in some of these cases of old-standing dislocation of the elbow, in order to facilitate reduction. In those instances, in which I have done this operation or seen it adopted, but little, if any, good has resulted; and I have known troublesome sloughing to ensue. As a general rule, I believe that it will be found extremely difficult, even under anæsthesia and with the aid of the pulleys, to reduce an ulna that has been completely dislocated for more than a month. When the ulna is only partially dislocated, even though the radius be completely displaced, reduction may be effected without much difficulty at a very much later period—it is said, as late as two years after the accident; but here the difficulty is not to effect but to maintain the reduction and keep the bone in position, as it has a constant tendency to slip forwards and outwards. Provided a dislocated elbow can be so far reduced as to allow the fore-arm to be bent at a right angle, an useful arm will be left.

Dislocations of the Wrist are of rare occurrence; so much so, that their existence has been denied by Dupuytren and other modern Surgeons of great experience. Although there can be no doubt that fractures of the lower end of the radius, more especially of an impacted character, have often been mistaken for these displacements, yet there can be now no question that they do occasionally, though rarely, occur. Any doubt that may formerly have existed upon this point, in consequence of the want of *post-mortem* examinations, has been in recent years cleared up by the dissection of cases that have been made by Marjolin and Voillermier. The observations of these Surgeons, together with those previously made by Sir A. Cooper, tend to show that dislocation of the **Hand and Carpus** from the radius may take place either *backwards* or *forwards*.

These accidents are occasioned either by falls on the palm, or by the hand being forcibly bent forwards. In falls on the palm, the hand may be thrown forwards under the bones of the fore-arm, lying on their palmar aspect. In forcible bending of the hand forwards, there may be displacement of it and the carpus backwards on the dorsal aspect of the radius and ulna.

In the **Dislocation of the Hand and Carpus Backwards**—the **Dorsal** displacement—there will be shortening of the length of the limb below the elbow, with a large dorsal prominence occasioned by the carpus overlapping the lower end of the radius, which bone will be felt and seen as a projection on the palmar side. In the other variety of radio-carpal dislocation, the **Hand and Carpus are thrown Forwards** under the radius and ulna on their **Palmar** aspect. This dislocation is illustrated in the accompanying figure taken from a cast sent to me by Cadge of Norwich (Fig. 218). In it the projection of the styloid process of the ulna and the lower end of the radius form a concave line on the dorsal aspect, overlapping the carpus, which lies on the palmar side of the radius.

Fig. 218.—Dislocation of the Hand and Carpus forwards.

The *Diagnosis* of these injuries has to be made from sprains of the wrist, from simple and from impacted fractures of the radius. From sprains of the wrist, the great and prominent deformity will at once enable the Surgeon to distinguish a dislocation. From simple fracture of the lower end of the radius, the peculiar deformity, and the absence of crepitus, will afford ready means of diagnosis. It is from the impacted fracture of the lower epiphysis of the radius that it is most difficult to distinguish a dislocation. In the dislocation, however, the great laxity of the wrist-joint, the greater readiness with which the deformity is removed, the peculiar and abrupt swelling, and the absence of obliquity of the hand towards the radial side, will enable the Surgeon to distinguish the true nature of the injury.

The *Treatment* of these cases is simple, and in accordance with general principles. Reduction, which is readily effected, must be maintained by the application of antero-posterior splints of sufficient length to take in the hand.

Compound Dislocation of the Wrist, without fracture of the bones of the fore-arm, is a rare accident. In one such case which came under my care at the Hospital, in consequence of injury inflicted on the arm by machinery, the hand was thrown forwards, the radius projecting backwards, and the soft structures on the palmar aspect of the joint were so extensively torn through as to necessitate amputation. The *Treatment* of such a case will depend on the amount of injury done to the soft parts. If these be not very extensively injured, an attempt may be made to save the limb; but if they be widely torn through, the arteries and nerves lacerated, and the tendons perhaps hanging out, amputation will be required; this occurred, and the operation was performed, in the case to which I have just referred. This will be rendered more imperative if the bones of the fore-arm be comminuted as well.

Congenital Dislocation of the Wrist may take place either forwards or backwards. The limb is in either case greatly deformed. The bones are shortened and altered in shape, more especially the lower end of the radius. The muscles are also shortened, the extensor tendons forming a sharp angle as they pass over the carpus.

Dislocations of Single Bones of the Carpus are by no means frequent. The bone that is most commonly displaced is the **Os Magnum**.

This accident usually happens from falls, in which the hand is violently bent forwards, in consequence of which this bone starts out from its articulation, projecting as a round hard tumor on the back of the wrist opposite to the metacarpal bone of the middle finger. It may be readily reduced by being pressed upon while at the same time the hand is extended. There is, however, a great tendency for this bone to slip out again, leaving considerable weakness of the joint; so much so, that, in two cases recorded by Sir A. Cooper, the patients found it necessary to wear artificial supports.

The **Pisiform Bone** is occasionally dislocated upwards. In a case under my care, it was displaced by an effort to lift a heavy weight, and drawn up the arm to a distance of nearly an inch by the flexor carpi ulnaris.

A case some time ago occurred to me, at the Hospital, in which the **Semilunar Bone** was dislocated. The patient had fallen from a height, injuring his spine, and doubling his right hand under him. On examining the wrist, a small hard tumor was felt projecting on its dorsal aspect; it readily disappeared on extending the hand and employing firm pressure, but started up again so soon as the wrist was forcibly flexed. It was evident that this bone belonged to the first row of the carpus, articulating with the radius; and from its size, its position towards the radial side of the carpus, and its shape, which could be very distinctly made out through the integuments, there could be little doubt that it was the semilunar bone. Taaffe, of Brighton, has related a case in which the semilunar bone was dislocated anteriorly, so that it projected upwards and forwards between the radius and ulna.

Dislocations of the Metacarpal Bones.—The **Metacarpal Bones** may possibly, though very rarely, be dislocated from the carpus. This accident usually happens to a single metacarpal bone; which, in consequence of some extreme degree of violence, is forced out of its bed and is thrown backwards on the carpus. Most frequently, this accident is the result of injury and shattering of the hand by gun-barrel or powder-flask explosions; and in such cases the metacarpal bone of the **Thumb** is the one that commonly suffers, the dislocation being also usually compound, and complicated with fracture of the bones and extensive palmar laceration. Dislocation of the metacarpal bone of the thumb, however, is rare, though the articulation between this bone and the trapezium appears at first not to be of a character to resist much external violence. This is probably owing in a great measure to the powerful muscles by which the bone is supported in all cases in which the force is applied upon its palmar aspect, as it most frequently is, as well as to the little leverage offered by so short a bone. Luxation, however, of the metacarpal bone of the thumb has been observed to take place *forwards* as well as *backwards*, the latter being the most common. The *Reduction* is in general easy, extension being made from the thumb by means of a piece of tape applied round the first phalanx.

Next to the metacarpal bone of the thumb, those of the **Index** and **Middle Fingers** are most liable to dislocation backwards: sometimes complete, at others incomplete.

I am not acquainted with any case on record in which *all* the metacarpal bones have been dislocated from the carpus. The annexed engraving (Fig. 219) is from a cast in University College Museum, taken from a patient in the Hospital, in whom I believe that this accident must have occurred; the hand being thrown forwards and shortened, and the carpal bones forming a rounded and *convex* prominence on the

dorsum of the metacarpus. The convex appearance of this corresponds with the outline of the carpal bones, and differs so very remarkably from the concave aspect of the lower end of the radius and ulna, as seen in the radio-carpal dislocation (Fig. 218), that I think there can be little doubt as to the nature of the injury sustained by the patient.

Fig. 219.—Dislocation of the Metacarpus, forwards, from the Carpus.

The *Treatment* of such cases will be the same as that for ordinary dislocations of the carpal bones; splints of sufficient length to take in the hand being applied, after reduction, in order to maintain the parts in position.

Dislocations of the Metacarpo-Phalangeal Articulations are by no means of common occurrence. They are usually produced by falls on the hand, and are met with at all ages; most commonly in the young adult, but sometimes at an earlier age. I have seen this accident in a child four years old. Most frequently the **Proximal Phalanx of the Thumb** is the bone that is dislocated, being thrown *backward* on the metacarpal bone (Fig. 220) in such a way that the articular surface of the phalanx rests upon the back of the metacarpal bone immediately below its head. The signs of the accident are sufficiently evident. In the normal state of the hand, the metacarpo-phalangeal articulation of the thumb is convex backwards: in this dislocation it becomes convex toward the palmar aspect and angularly concave behind. The head of the metacarpal bone can be felt and seen projecting on the palmar aspect of the thumb. The proximal phalanx stands up as it were upon the back of this bone, but the articular surface of the phalanx cannot be felt, owing to its being in contact with the posterior part of the metacarpal bone just above its neck. The phalangeal articulation is always semi-flexed. This dislocation of the proximal phalanx of the thumb has, owing to the difficulty of its reduction, attracted more attention from Surgeons than it would at first appear to deserve. So great has this difficulty been in some cases, as to render the dislocation irreducible, notwithstanding the employment of as much force as it was safe to use, and that most skilfully directed, or to compel the Surgeon to have recourse to operative interference in order to replace the head of the bone. The obstacle to the ready reduction of this small bone has been attributed to different causes. Thus, Hey supposed that it was owing to the constriction of the neck of the bone between the lateral ligaments of the joint. Dupuytren entertained a very similar opinion, looking upon the malposition of these ligaments as the principal source of difficulty. The folding in of the anterior ligament of the joint, and the interposition of a sesamoid bone between the articulating surfaces, have also been looked upon as giving rise to this peculiar difficulty in reduction. The more probable explanation, however, appears to be that the narrow neck of the metacarpal bone becomes locked between or con-

Fig. 220.—Dislocation, backwards, of the Proximal Phalanx and Thumb.

stricted by the two terminal attachments of the short flexor of the thumb, which must be carried back over its broader head, together with the displaced phalanx; the head of the metacarpal bone being grasped between these tendons and the torn capsule of the joint, like a stud between the sides of a button-hole. The observations of Vidal, Malgaigne, and Ballingall point to this as the cause of the great difficulty in reduction that is often met with.

Reduction.—Although, as has been said, great difficulty in reduction is often met with, it would be a great error to suppose that it always exists. On the contrary, very many of these dislocations are, under chloroform, most readily reduced by simple traction and manipulation (Fig. 220). Should any difficulty be experienced, the following plan will usually answer. The hand and metacarpal bone being fixed by an assistant, the Surgeon bends back the thumb, so as to bring the phalanx to a right angle with the metacarpal bone on which it is displaced. He now employs traction in the axis of the displaced portion of the thumb, keeping the metacarpal bone well pressed down into the palm. Having thus unlocked the phalangeal articular surface from the back of that bone, he draws it well forwards, and, when it is opposite the head of the metacarpal bone, bends it down into the palm. In this way I have reduced a dislocation of the phalanx backwards between five and six weeks after its occurrence. Simple traction in the straight direction, however forcible, and even when aided by the pulleys, will do little if

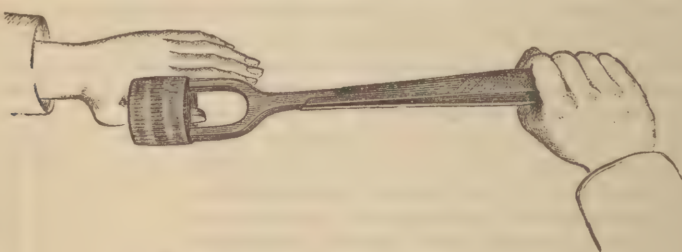


Fig. 221.—Reduction of Dislocation of Thumb.

any good in the reduction of this dislocation, as the only effect is to draw the slit in the capsule and the two heads of the short flexor more tightly than ever round the neck of the bone. Very severe extension has been employed without any effect; and there is the tradition in the surgical profession in London of a thumb having been dragged off in the attempt to reduce this dislocation by pulleys. If the Surgeon fail in reducing the dislocated phalanx by manipulation under chloroform as above described, or by traction, what is to be done? In these circumstances, the dislocation should not be left without a further effort to replace the bone; and this may usually be readily enough done by the subcutaneous section of the resisting structures. The Surgeon must bear in mind that the obstacle to reduction is purely mechanical; that muscular contraction has nothing to do with it; and that it is quite as great when the patient is anæsthetized as when he is not. He must therefore enlarge the slit in the capsule, and divide the tense bands formed on each side by the tendinous attachments of the short flexor. This operation is best done by passing a tenotome through the skin in front of the joint, and cutting first on one side, then on the other. The chief resistance will be found on the ulnar side of the thumb, where the ten-

dinous insertion of the abductor pollicis is probably divided at the same time as that of the short flexor or thumb. After these structures have been cut through, the phalanx can be replaced, and the thumb should be put up securely between splints.

When reduction has been effected, care must be taken to prevent the recurrence of the displacement. This is best done by keeping the thumb bent into the palm, and retaining it there by means of a gutta-percha cap moulded over it and bandaged down. If the dislocation be left unreduced, the thumb will to a great extent become useful, but necessarily shortened, deformed, and incapable of much flexion.

In *Compound dislocation* of this joint, the bone may usually readily be replaced; should there be any difficulty in retaining the bone in position, its head must be removed, the dislocation being then reduced with great readiness, and the wound treated in a simple manner.

Dislocations between the Phalanges rarely occur. These dislocations are partial or incomplete, and usually consist of a twist of the second upon the proximal phalanx. I do not think that simple dislocation of the ungual phalanx from the second is possible. Partial dislocation of the middle phalanx, which is a very common accident, is readily recognized by the deformity it entails (Fig. 222), and is easily reduced by pressure and traction in proper directions. A very convenient mode of applying traction is by means of the toy called an "Indian puzzle," which grasps the finger more tightly the more it is pulled upon. The finger will continue to be stiff and comparatively useless for some length of time. The joint being swollen and tender the patient can generally bend it, but cannot extend it fully or bear any traction upon it. This condition is especially apt to be troublesome and chronic if the patient be gouty, or if his general health be otherwise deranged, and requires rest and local counter-irritation, with an antipodagric treatment, for its remedy. In *Compound dislocation* of the phalanges, the bone should be replaced, the finger supported by a gutta-percha splint, and the wound dressed lightly. In some cases it is necessary to remove the projecting end of bone before this can conveniently be done: ankylosis then results, a sufficiently useful finger being left.

Fig 222.—Partial Dislocation of the Middle Phalanx of the Middle Finger.

DISLOCATIONS OF THE LOWER LIMB.

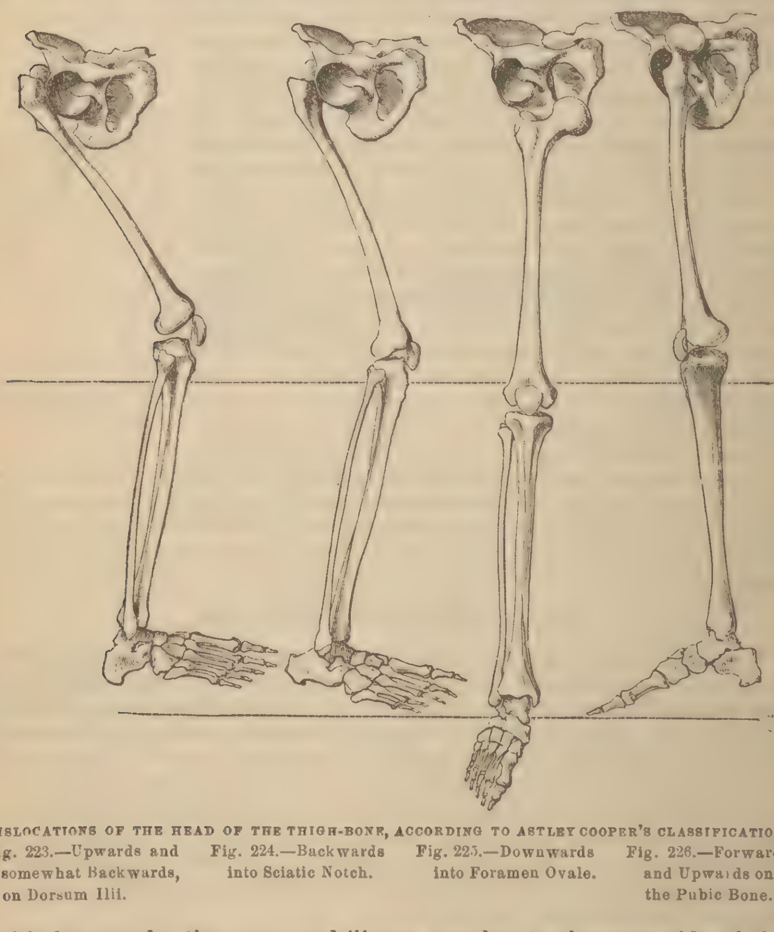
Dislocations of the Pelvis.—It often happens that, in consequence of severe blows upon or compression of the pelvis, the **Symphysis of the Pubic Bones**, or more frequently the **Sacro-iliac Articulation**, is displaced. Here the nature of the injury is indicated by the deformity that results; and the same treatment is required as in fracture of the pelvis, with which these accidents are commonly associated.

The **Coccyx** is sometimes violently bent, and almost dislocated *forwards* by falls; or it may be forcibly bent *backwards* during violent parturient efforts. These accidents may be remedied by manipulation through the rectum; but are apt to be followed by that painful neuralgic affection **Coccydinia**, described at p. 427.

Dislocations of the Femur.—Notwithstanding the great depth of the acetabulum, the complete manner in which the head of the thigh-bone is received into its cavity, the firmness of the capsular ligament, and the

great strength of the capsular muscles that surround and support the joint, dislocations of the hip are more frequently met with than those of many other joints that appear less perfectly supported. This is doubtless in a great measure owing to the action, on the head of the femur, of the great length of leverage of the thigh-bone itself when external violence is applied to the knee, and of the whole of the lower extremity when the violence is applied to the foot.

The different forms of dislocation of the femur were described with great clearness and precision by Sir A. Cooper, who showed that its head is most commonly thrown **upwards and somewhat backwards**, so as to lodge on the slightly concave surface between the acetabulum and the crista ilii, resting on the gluteus minimus, and having the trochanter turned forwards (Fig. 223); or the head may be thrown **downwards** into the foramen ovale, lying upon the obturator externus muscle (Fig. 225); or **forwards and upwards** upon the horizontal branch of the



DISLOCATIONS OF THE HEAD OF THE THIGH-BONE, ACCORDING TO ASTLEY COOPER'S CLASSIFICATION.
Fig. 223.—Upwards and somewhat Backwards, on Dorsum Ilii. Fig. 224.—Backwards into Sciatic Notch. Fig. 225.—Downwards into Foramen Ovale. Fig. 226.—Forwards and Upwards on the Pubic Bone.

pubic bone under the psoas and iliacus muscles, to the outer side of the femoral vessels (Fig 226); the head of the bone may also be thrown **backwards** into the sacro-sciatic notch, resting upon the pyriform is

muscle (Fig. 224). These are the four forms of the dislocation of the hip stated by Sir A. Cooper to be the most usual, and this statement has been fully confirmed by the accumulated experience of more modern Surgeons. Besides these, however, may be added, as not very unfrequent, that form in which the bone is thrown **backwards and somewhat downwards** behind the tuberosity of the ischium. In addition to these, other less common forms of dislocation have been noticed: for instance, one in which the head of the bone lies between the anterior superior and the anterior inferior spinous processes of the ilium, or that in which it has been thrown upon the spine of the ischium.

The extent of mischief done to the soft parts around the joint varies in different dislocations. In all, the capsular ligament is torn in a greater or less extent in the direction of the displacement. The extent and exact situation of the laceration of the capsular ligament are matters of great importance, as on a correct appreciation of them depends in a great measure the facility or difficulty in reduction, and the means to be employed in effecting it. The ligamentum teres is ruptured in most cases, but not necessarily in all: Dupuytren and Sédillot both mention cases of dislocation on the dorsum ilii in which this ligament escaped without rupture. In the dislocation on the dorsum ilii, Sir A. Cooper found the gemelli, obturatores, and quadratus completely torn across, and the pectineus slightly torn. In the dislocation into the sciatic notch, Billard d'Angers found the gluteus maximus and medius torn, and the gemelli rupturee. Syme found the gluteus maximus extensively torn, with the head of the bone imbedded in it; the gluteus minimus, the pyriformis, and the gemellus superior lacerated; and the head of the femur lying upon the gemelli and the great sciatic nerve. In the displacement on the obturator foramen, the pectineus and adductor brevis are torn. In the dislocation on the pubic bone, the extent of injury is more uncertain. In one case related by Sir A. Cooper, Poupart's ligament was torn up, and in another the pectineus and adductors were torn; but whether this was done by the dislocation or by the direct injury that occasioned it, is uncertain. Dr. MacCarthy has described the appearances found on dissection in two cases of dislocation of the femur on to the dorsum ilii. In one, the deeper fibres of the gluteus maximus had been torn by the head of the bone, which was found lying with its anterior part on the brim of the acetabulum, with the lowermost fibres of the gluteus minimus interposed, and the dimple for the ligamentum teres directed backwards and inwards. The posterior fibres of the gluteus medius were also torn, and the pyriformis, obturator internus, and gemelli muscles had been completely torn from their pelvic attachments. The quadratus femoris was uninjured. The capsule had given way posteriorly; in front and above it was intact. Although some fibres of the ligamentum teres had been ruptured, the ligament still resisted all attempts to break it. The ilio-femoral and pubo-femoral bands were uninjured, notwithstanding that the acetabulum had separated into its three component parts, the fracture traversing also the ilio-pectineal eminence. The lowermost fibres of the external oblique muscle of the abdomen, and some fibres of the sartorius, psoas magnus, and iliacus internus muscles were also ruptured. In the second case, the gluteus maximus was not torn, but the bursa between it and the vastus externus was seen to be ruptured and filled with blood. The sheath of the great sciatic nerve was also distended with blood, and the nerve-fibres were separated from one another. The posterior fibres of the gluteus minimus muscle were torn across, and the areolar tissue beneath that muscle filled with blood. The quadratus

femoris muscle was torn completely in two, and the uppermost fibres of the adductor magnus, and some fibres of the gemelli and obturator internus muscle, were lacerated. The capsule was perfect in front and above, but torn at the most posterior part. The ligamentum teres had been torn off close to the femoral attachment.

The importance of the **ilio-femoral ligament** in the mechanism of dislocation of the hip-joint has been fully recognised by various Surgeons. Gunn of Chicago, Busch, Von Pitha, and, more recently and fully, Bigelow, have insisted on an exact knowledge of this important ligament as constituting the basis of a correct understanding of the mechanism, not only of the various forms of dislocation of the hip, but also of the proper mode to be adopted for their reduction. Bigelow, to whom we are especially indebted for a most lucid exposition of the subject, gives this structure, from its shape, the name of the Y-ligament; and he believes that, while its branches are unbroken, one or other of the four regular dislocations of the hip will occur; the particular dislocation depending upon the relative positions of the head of the femur and the ilio-femoral ligament. In no case, however, do any of the muscles, except, perhaps, the obturator internus, exercise any influence on the displacement. When the Y-ligament is ruptured, an irregular dislocation, the signs of which may be uncertain, will occur. The strength of this ligament is always great, although it varies much. Bigelow has found that its breaking power in the dead body ranges from 250 to 750 pounds.

The next structure of most importance, as has been pointed out by Bigelow, is the *obturator internus muscle*. He has shown that its muscular body is usually intermixed with tendinous structure. In consequence of this arrangement, it acquires great strength when contracted, and, indeed, becomes practically an accessory ligament.

Bigelow classifies dislocations of the head of the thigh-bone into **Regular Dislocations**, in which one or both branches of the Y-ligament remains unbroken; and **Irregular**, in which the Y-ligament is wholly ruptured. The *regular* dislocations in which both branches remain entire, are: 1, Dorsal; 2, Dorsal below the tendon (ischiatic of Cooper); 3, Thyroid and downward; *a*, obliquely inward on the thyroid foramen; *b*, obliquely inward as far as the perinæum; *c*, vertically downward beneath the acetabulum; *d*, obliquely outward as far as the tuberosity; 4, Pubic and Subspinous; 5, Anterior oblique. Those in which the external branch is broken are: 6, Supraspinous; and 7, Everted Dorsal.

With regard to the relative frequency of the various forms of dislocation of the hip, Sir A. Cooper says, that of 20 cases of dislocation of the hip, 12 will, on the average, be on the dorsum illi, 5 on the sciatic notch, 2 on the obturator foramen, and one on the pubic bone. Hamilton states that, excluding anomalous cases, of 104 cases of dislocation of the hip which he has collected, 55 were on the dorsum ilii, 28 into the sciatic notch, 13 into the obturator foramen, and 8 upon the pubic bone.

Dislocation of the hip-joint chiefly occurs in young or middle-aged adults. In very old people, fracture of the neck of the femur will commonly be produced by the same violence that would have displaced the head of the bone at an earlier age. In children dislocation is rare, as the shaft generally gives way. Yet it does happen even at a very early age. Two cases have occurred in my practice at the Hospital. In one the bone was dislocated on the pubic bone, in a child a year and a half old; in the other on the dorsum ilii in a boy of six.

For convenience of description, and with a view to practical utility, we may arrange dislocations of the hip-joint in three principal varieties.

1. **Dislocations Upwards and Backwards.**—The most common dislocation is that in which the head of the bone is thrown *upwards and backwards* upon the dorsum of the ilium, or rather upon that portion of the bone which extends between the acetabulum and the sacro-sciatic notch (Fig. 223). This displacement differs so slightly in its pathology and treatment from the dislocation into the sciatic notch (Fig. 224) described as a distinct variety of the injury by Sir A. Cooper, that I think it is more consistent with the true nature of these accidents to look upon them as essentially the same; the displacement in both cases being upwards and backwards, but in different instances partaking more of one or other direction. This dislocation may therefore be described as the **Ilio-sciatic**; it corresponds with Bigelow's first and second classes of regular dislocation.

2. **Dislocation Downwards.**—Next in order of frequency to the ilio-sciatic dislocation is the **Thyroid**, in which the head of the bone is thrown downwards on the obturator foramen (Fig. 225). The downward dislocations include also those on the perinæum and beneath the acetabulum.

3. **Dislocation Upwards.**—In the **Pubic** variety, the head of the bone is thrown upward on the pubic bone (Fig. 226). In a more rare variety of upward dislocation, it may lie below the anterior inferior spine of the ilium.

Thus it will be seen that, in whatever direction the displacement occurs, the head of the bone has a tendency to sink into some cavity or depression, or to lie upon one of the osseous surfaces in the neighborhood of the acetabulum. It is also probable that the hip can be partially dislocated.

In the **Reduction** of dislocation of the hip-joint, two methods may be employed. The first, or the old method, consists in making *extension* by means of forcible traction by pulleys or otherwise in the direction of the axis of the displacement of the limb, and overcoming, by main force, any obstacle arising from muscular contraction or ligamentous resistance. The other, or modern method, consists in the employment of *manipulation*, by which is meant the avoidance of all force, the relaxation of the muscular structures by flexion, and the disentanglement of the head of the bone from any ligamentous obstacle by impressing on it various rotatory movements, each adapted to the particular case. Originally advocated by Nathan Smith in 1831, extended by Reid of Rochester (U. S. A.) in 1851, this method has now in America, and very commonly in this country, superseded the forcible extension of Sir A. Cooper and the older surgeons in the reduction of all *recent* dislocations of the hip. In those of *old standing*, extension by means of the pulley is still required, as by manipulation sufficient force cannot be exerted to overcome those secondary causes of resistance that become developed in such cases. There is a third method—that by *angular extension*, invented by Ponteau; but, as this is less effective than either of the others, and never, I believe, now employed, its consideration need not detain us.

I shall describe each method of reduction in connection with each of the principal forms of dislocation of the hip.

1. **Dislocation Upwards and Backwards, or Ilio-sciatic.**—If the head of the bone rest upon the **dorsum of the Ilium** (Fig. 223), the hip will be found to be a good deal distorted, the gluteal region being somewhat prominent, and the upper part of the thigh enlarged, in consequence of the approximation of the muscular attachments, so as to

give an appearance of widening to the hip. The head of the bone can be felt in its new situation, more especially on rotating the limb; the trochanter is less prominent than natural, usually lying close against the brim of the acetabulum, and being turned forwards; there is marked shortening, varying from one to two inches in some cases, perhaps even as much as three inches. The amount of shortening will necessarily depend upon the distance to which the head of the bone is thrown *upwards* on the dorsum. The position of the limb is remarkable, being distinctly rotated inwards, with thigh slightly bent upon the abdomen, and the leg upon the thigh, so that the knee is semi-flexed, and raised from the surface on which the patient is lying. The foot is inverted, so that the ball of the great toe rests on the instep or against the ankle of the sound limb; and the heel is somewhat raised. The axis of the dislocated thigh is directed across the lower third of the sound thigh. The movements of the joint are greatly impaired: abduction and eversion are not practicable; but inversion, adduction, and some flexion upon the abdomen, can be practised. When the patient is lying flat, with the knee slightly raised and advanced, the lumbar spine is on its proper level; but if an attempt be made to straighten the knee, so that the limb lies flat, the lumbar spine will arch forwards.

When the head of the bone slips a little further back so as to become lodged in the **sciatic notch**, we have the dislocation "backwards" of Sir A. Cooper; or, as Bigelow calls it, "dorsal below the tendon," because the head of the bone lies below the tendon of the obturator internus muscle (Fig. 224). In this the same symptoms exist, though to a less degree; hence the diagnosis is proportionately difficult. There is much less deformity about the hip in this variety of the displacement, owing to the head of the bone sinking into the hollow of the notch, and thus presenting the trochanter nearly in its usual position at right angles with the ilium, though somewhat behind and a little above its normal situation. In consequence of the head of the bone being received in a depression, the axis of the limb is not altered to the same extent as when it is thrown upon the plane surface of the dorsum ilii; hence the inversion of the knee and foot, though existing, is usually not so strongly marked. Bigelow, however, says that the inversion is greater in the dislocation "below the tendon" (Fig. 227). As the sciatic notch is but a little above the level of the acetabulum, the shortening of the limb is inconsiderable, not exceeding half an inch or an inch at most. The axis of the limb also is directed across the sound knee. Thus the signs of these two forms of dislocation are nearly identical in character, though varying in degree; the principal difference being that, when the head of the bone rests in the sciatic notch, the axis of the femur is directed to the opposite knee, whereas, when the head of the bone is lodged on the dorsum ilii, the axis of the limb is directed across the lower part of the sound thigh.

Fig. 227.—Dislocation below the Tendon. Much inversion. (Bigelow.)

Causes.—The dislocation upwards and backwards is that which is most frequently met with in the hip. It is occasioned by violence acting upon the limb whilst adducted, with the body bent forwards upon the thigh, or the thigh upon the abdomen; as when a person is struck on the back with a heavy weight, or is thrown forwards, or falls whilst

" " " downw, " "

" " " out, " in, bend in

carrying a heavy load upon his shoulders, when the upper and posterior part of the joint receives the whole of the strain. In these circumstances, the capsular ligament is ruptured, and the bone slips out of its articulation.

The *Diagnosis* of this form of dislocation is easy in proportion as the head of the bone lies high on the dorsum ilii. The more it sinks towards and into the sciatic notch, the more difficult does the detection of the displacement become, and the greater the risk of its being overlooked altogether, or mistaken for a sprain. In ordinary cases of fracture of the neck of the thigh-bone, the eversion of the limb at once points out that the head of the bone is not dislocated on the ilium. The only severe injury of the hip with which the dislocation upwards and backwards can be confounded, is the rare case of *fracture of the neck of the thigh-bone, with inversion of the limb.* In this accident the increased mobility, and the existence of crepitus, will enable the Surgeon to effect the diagnosis. Should, however, the fracture be an impacted extracapsular one, with inversion, then the difficulty of diagnosis is undoubtedly great. A correct conclusion may, however, be arrived at by observing that in the fracture the flattened trochanter is approximated to, and is in nearly a perpendicular line with, the anterior superior spine of the ilium ; whilst in the dislocation the trochanter is diagonally behind that process of bone, and the head of the thigh-bone can be felt in its new situation by deep manipulation of the gluteal region.

Reduction of Iliac Dislocation by Rotation.—The patient being laid on his back and fully anæsthetised, the Surgeon flexes the thigh upon the abdomen, so that the head of the bone is lifted out from behind the acetabulum. The limb should now be slowly abducted, and rotated outwards. By this manœuvre the head revolves around the great trochanter, which is fixed by the outer branch of the Y-ligament, and rises into its articular cavity. The movement is facilitated by carrying the limb downwards as well as outwards. Bigelow has summarised the movements necessary to effect reduction in this way in the following words, "*Lift up, bend out, roll out.*" In some cases slight rotation *inwards*, instead of outwards, succeeds best. In others, again, it may be necessary for the Surgeon to place his foot, covered only with a stocking, on the anterior superior spinous process, to steady the pelvis while he raises the bent knee.

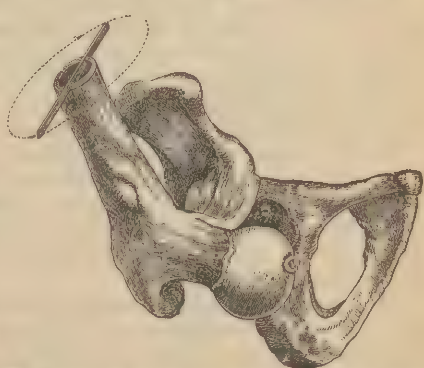


Fig. 228.—Dorsal Dislocation. Reduction by Rotation. The limb has been flexed and abducted, and it remains only to evert it and render the outer Branch of the Y-ligament tense by Rotation. (Bigelow.)

Reduction by Extension is effected in the following manner. The patient, having been put under the influence of chloroform, is laid on his back upon a strong table. One staple should then be fixed in the floor near the head of the bed at the side corresponding to that of the dislocated limb, while another staple is placed in the wall at the foot, above the level of the body, in a direct line with the axis of the limb, and about twelve feet from the other. The counter-extending force must then be

made by a jack-towel or a padded leather belt passed between the injured thigh and the perinæum, and fixed to the staple in the floor. The pulleys must now be attached to proper straps, or to a towel fixed with a clove-hitch knot immediately above the knee, at one end; the other extremity being attached to the staple in the wall, which should be so situated as to be continuous with the axis of the lower part of the limb. The knee being then slightly bent and rotated inwards, traction is applied slowly and steadily until the head of the bone has approached the acetabulum, when the Surgeon rotates the limb outwards so that the head may slip into its socket (Fig. 229). The fact of the reduction being accomplished

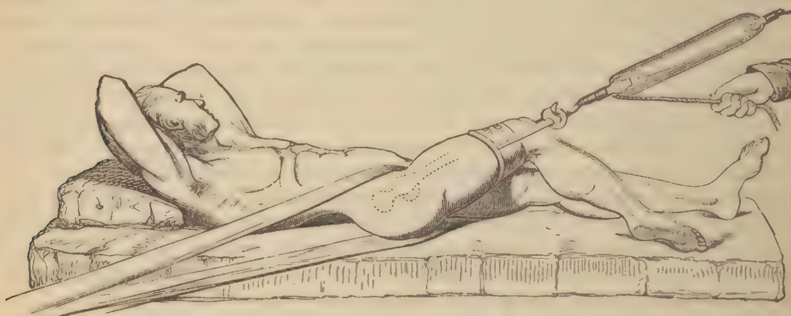


Fig. 229.—Reduction of Ilio-sciatic Dislocation by Extension.

is ascertained, by comparing the bony points of the limb with those of the opposite side, and seeing if they correspond. A long splint and spica bandage should now be applied to fix the thigh, and the patient be kept in bed for a fortnight, so that reunion of the ruptured tissues may take place. In reducing this dislocation, there is some danger of the head of the bone slipping downwards into the sciatic notch, if the limb be too much raised. This accident, which has happened to some very excellent Surgeons, may be mistaken for reduction of the bone; a serious mistake, which would, unless corrected, entail permanent lameness.

Reduction of recent Dislocation into the Sciatic Notch should be effected by **Manipulation.** This may usually be done by laying the patient flat on his back, fixing the pelvis, raising the thigh at a right angle so as to unlock the head of the bone and bring it below the acetabulum. It may be jerked into this cavity by bringing the foot down and rotating outwards at the same time.

Sir A. Cooper found great difficulty in the reduction of the dislocation; and he and Lisfranc, amongst other Surgeons, have failed to reduce it by extension. In the reduction by **Extension,** the patient is laid on his sound side instead of on his back, and extension is made over the middle of the opposite thigh instead of immediately above the knee, as in the iliac dislocation.

opens
duction

In either of these dislocations, if difficulty arise in raising the bone over the head of the acetabulum, recourse may be had to the plan recommended by Sir Astley Cooper, of lifting the head of the bone out of the notch and over the edge of the acetabulum by means of a round towel, placed under the upper part of the thigh and over the shoulders of an assistant, who, first stooping and at the same time resting his feet on the patient's pelvis, should then raise his shoulders and draw the bone towards its sockets.

Bigelow describes as allied to the sciatic dislocation (dislocation be-

low the tendon), and constituting a stage of it, that displacement in which the head of the bone is thrown **downwards and outwards towards the tuberosity of the ischium,** lying on the posterior part of the body of that bone between the tuberosity and the spine. The head of the bone can be felt in this situation; and the limb is inverted (Fig. 230). Bigelow considers this as the first step towards luxation behind the tendon, which it tends to become when the patient is upright.

Fig. 230.—Dislocation Downwards and Outwards towards the Tuberosity below tendon. (Bigelow.)

2. **Dislocation Downwards.**—Of this class of dislocations, that on the **Thyroid Foramen** is the most frequent. In it, the hip is flattened, and the prominence of the trochanter completely absent, or indeed replaced by a depression. The limb is lengthened by about two inches, advanced before the other, and considerably abducted (Fig. 231). The knee is bent and incapable of extension; the foot usually points forwards, but is sometimes slightly everted, and is widely separated from its fellow. When the patient stands, the body is bent forwards in consequence of the tension of the psoas and iliacus muscles, and in a thin person the bone may be felt in its new situation. When he lies on his back, the knee is much raised and the thigh flexed.

Causes.—This dislocation appears to be occasioned by the limb being suddenly and violently abducted, as by falls with the legs widely separated; in consequence of which the head of the bone is tilted against the inner side of the capsule, and, rupturing this, is thrown into the thyroid notch.

Fig. 231.—Thyroid Dislocation. (Bigelow.)

Fig. 232.—Reduction by Manipulation in Thyroid Dislocation. Rotation and Circumduction Inwards of Head of Femur. (Bigelow.)

Reduction by Manipulation must be done as follows. The limb, having been flexed on the abdomen so as to bring it into a perpendicular position, must be slightly abducted so as to disengage the head of the

bone. The thigh is then to be strongly rotated inwards, and adducted, the knee being carried towards the floor (Fig. 232).

Reduction by Extension is to be done in the following manner. The patient is laid on his back; the counter-extending girth, or towel, is then placed round the pelvis and fixed firmly to a staple next to the sound side of the patient. A padded girth is then to be placed between the perinæum and the upper part of the dislocated thigh. From this, extension is made by means of the tourniquet or the pulleys, which are fixed to a staple at a little distance from the injured side of the patient. Extension having then been made to such a degree as to elevate the head of the bone from the depression in which it lies, the Surgeon passes his hand behind the sound leg, and, seizing the ankle of the injured limb, presses it backwards and draws it towards the mesial line, taking care to keep the knee straight, and thus throwing the head of the bone into the acetabulum by the action of a long lever (Fig. 233).

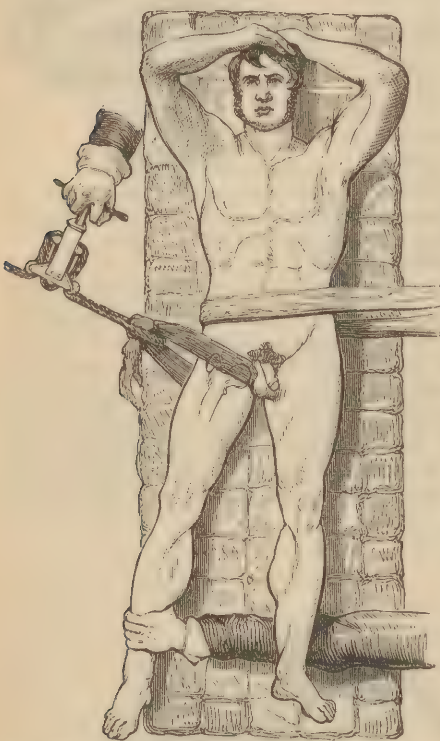


Fig. 233.—Reduction of Dislocation into Obturator Foramen by Extension.

The following are more rare forms of dislocation downwards.

The head of the thigh-bone may be thrown **directly downwards**, so as to rest *on the lower margin of the acetabulum*, between the sciatic notch and the thyroid foramen. Two cases of this injury have been recorded by Gurney of Camborne, and one by Luke. In it, there is less eversion of the limb than in the thyroid dislocation (Fig. 234). Bigelow has pointed out that the head of the bone, when thrown below the lower margin of the acetabulum, may be further displaced; either backwards on the dorsum ilii, or forwards to the thyroid foramen. In extreme flexion, however, the head may pass down as far as the *tuberosity or the ascending ramus of the ischium;* in the former case the limb is everted, and in the latter inverted, and in all cases flexed. The head of the bone may also pass **into the perinæum**, so as to be felt in its abnormal situation behind the scrotum. It has been known to compress the urethra, and thus give rise to retention of urine. The thigh is extremely abducted and stands out at a right angle with the body; and the toes may be either inverted or everted—which is ascribed by Bigelow to the want of firm bearing for the trochanter in the perinæum (Fig. 235).

In the **Reduction by Manipulation** of these two rare forms of dislocation downwards, the thigh is to be bent and its head guided

towards the socket. During this, the dislocation is sometimes converted into one of the thyroid or sciatic variety. In the dislocations downwards, vertical traction and slight inward rotation may be used; in the dislocations downwards and outwards, traction upwards and inwards, with abduction and rotation outwards; in the displacement downwards and inwards, traction upwards and outwards.

Fig. 234.—Dislocation directly downwards. (Bigelow.)

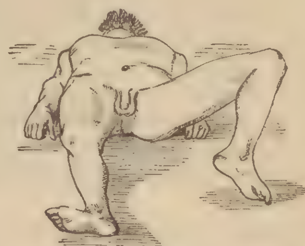


Fig. 235.—Dislocation downwards and inwards towards Perinæum. (Bigelow.)

Probably allied to these forms of dislocation is that in which the head of the bone has been found thrown **downwards and backwards into the lesser sciatic notch**. In these cases there is considerable shortening, but the position of the limb appears to vary. In an instance that occurred to Keate, the limb was abducted and the toes turned outwards. In a case reported by Wormald, the limb was turned inwards. Although the limb is described as shortened in these cases, Warren has related a case in which it was elongated.

3. **Dislocation Upwards.**—The dislocation upwards **on the Pubic Bone** presents very unequivocal signs. The hip is flattened;

Fig. 236.—Pubic Dislocation. (Bigelow.)

Fig. 237.—Pubic Dislocation. Head of Bone in Groin suspended by Y-ligament. (Bigelow.)

the head of the bone can be distinctly felt lying in its new situation above Poupart's ligament, to the outer side of the femoral vessels, where

it may be made to roll by rotating the limb. The thigh and knee are slightly flexed, rotated outwards, and abducted; the limb, which is separated from its fellow, is shortened to the extent of an inch (Figs. 236, 237).

The *Cause* of this dislocation is either direct violence applied to the back of the thigh whilst the limb is abducted; or it arises from the patient making a false step in walking, and suddenly throwing his body backwards in order to avoid a fall, twisting and displacing the limb.

The **Reduction by Manipulation** should be effected by drawing the limb downwards, and at the same time raising it up so as to flex it gradually on the abdomen as the head of the femur becomes disentangled from its position. It may then be rotated inwards, and the head of the bone thus directed towards the acetabulum.

With regard to the **Reduction by Extension**, Sir Astley Cooper advises that the patient should lie upon his back with his legs widely separated; and that counter-extension being then made by a girth

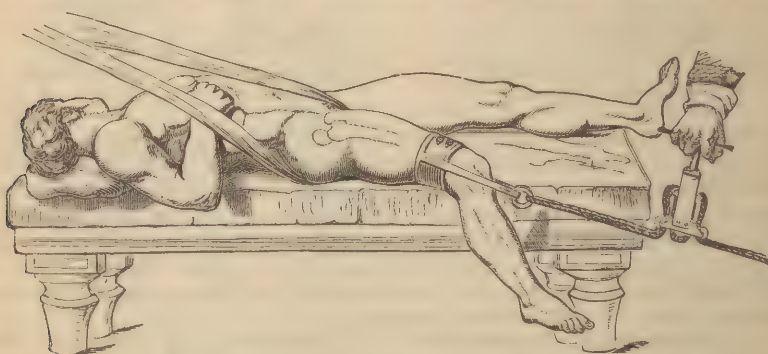


Fig. 238.—Reduction of Pubic Dislocation by Extension.

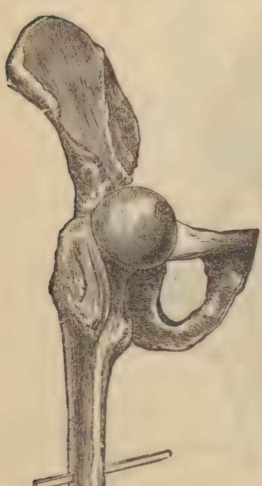


Fig. 239. — Subspinous Dislocation. The Y-ligament is stretched across the Neck of the Bone, which lies beneath it. (Bigelow.)

carried betweeen the perinæum and the injured thigh, and fixed to a staple in front of and above the body, the pulleys should be fixed upon the lower part of the thigh, and the extension made downwards and backwards. After this has been continued for a sufficient time, an assistant lifts the head of the bone by means of a towel over the brim of the acetabulum (Fig. 238).

The head of the thigh-bone may also be thrown **under the anterior inferior spinous process**, constituting the **Subspinous Dislocation** of Bigelow. There is shortening of the limb, which is everted, but less abducted or advanced than in the dislocation on the pubes. The head of the bone can be felt in its new situation.

In the dislocations above described, the Y-ligament remains entire. Bigelow describes also **Supraspinous Dislocation** with or without rupture of the outer branch of the ligament. If this be not ruptured, the dislocation is called by him *anterior oblique:* in it, the thigh lies across the upper part of the cor-

responding limb, and is firmly locked in that position, with much shortening and some eversion. Reduction may be effected by extension of the limb and increased circumduction across the symphysis, with a little eversion if necessary to dislodge the head of the bone. By inward rotation, the head of the bone is thrown on the dorsum.

In the true *supraspinous dislocation*, the outer branch of the Y-ligament is ruptured: the limb is shortened and everted. In a case related by Cummins, the limb was shortened three inches. Reduction may be effected by circumduction inwards and eversion, by which the dislocation is rendered dorsal, and may be thus reduced as already directed.

Everted Dorsal Dislocation may occur when, in dislocation on the dorsum, the outer branch of the Y-ligament is broken; the integrity of this portion being necessary for the inversion of the limb.

Irregular Dislocations of the head of the thigh-bone occur when the Y-ligament is wholly ruptured. The displacement may take place in any of the above described directions; but the characters are inconstant.

Reduction of old Dislocations of the Hip-joint is attended not only with great difficulty, but with no small amount of danger. The probability of effecting reduction rapidly decreases with the length of time that the bone has been left unreduced, and this more in some dislocations than in others. Thus it is easier to reduce an old dislocation on the dorsum ilii than one into the sciatic notch. Dislocation of the head of the thigh-bone on the dorsum of the ilium may usually be reduced without any great difficulty, up to the end of the first fortnight. After that time the difficulty increases considerably; and, although reduction has frequently been effected in these cases up to the sixth or eighth week, yet it has also not unfrequently failed, notwithstanding persevering and repeated attempts. After two months have elapsed, the reduction is not only a work of great uncertainty, but also of no slight danger from suppuration in the soft parts, or fracture of the femur; and it is then seldom practicable. But cases have been reported, and are referred to at p. 464, in which these dislocations have been reduced at a much later period, even as late as six and nine months.

If the bone be left permanently unreduced, it will in time acquire considerable mobility; more particularly if lying in the sciatic notch, the patient walking readily with a shortened but otherwise useful limb

The attempt to reduce old dislocations of the hip-joint is necessarily attended with more or less danger. In some cases the soft parts have been extensively lacerated; in others fatal inflammation of the joint has ensued; and, in eleven cases with which I am acquainted, the thigh-bone was fractured. This accident has happened to Surgeons of such eminence as Travers, Vincent, Malgaigne, Physick of Philadelphia, to Gwynne of Brighton, to Blackman of Cincinnati, to Harris and Randolph of the Pennsylvania Hospital, to the Surgeons of the Northern Hospital in Liverpool, and to a practitioner in London now living. In most of these cases the bone gave way at its neck or below the trochanters; the dislocation was of course left unreduced, but the patients recovered without difficulty, the fracture being treated in the usual way. The cause of the fracture usually appears to have been the employment of force in a transverse or rotatory manner, after extension had been kept up for some considerable time. There is no proof that undue violence was used in any of these cases. It is probable that in some the femur had become weakened by disuse of the limb.

The **Complication of Fracture of the Femur with Dislocation of the Hip-joint** occasions a very serious state of things, that may baffle the most skilful efforts on the part of the Surgeon. The line of practice to be adopted must depend in a great measure on the seat of fracture. If this be situated below the middle of the thigh, the limb should be put up tightly in temporary splints, and an attempt made under chloroform to reduce the dislocation in the ordinary way by pulleys applied over the splints, or by manipulation. If the fracture be high up, near or at the neck, the patient should be put under chloroform, and an attempt then made by pressure on the dislocated head and manipulation to replace it. It is possible that this might be effected, as in similar injuries of the humerus, with comparatively little trouble. Should reduction in this way not be practicable, we may adopt the plan successfully employed by Badley, who, in a lad of eighteen, with dislocation on the dorsum ilii, and fracture of the displaced bone, allowed union of the fracture to take place, and then at the end of five weeks effected reduction.

Simultaneous Dislocation of both Hips, perhaps in different directions, or of one hip with fracture of the opposite thigh-bone, has been met with in some rare instances.

Congenital Dislocation of one or both hips is occasionally seen. In these cases the spine is bent forwards in the lumbar region (lordosis): the trochanter is approached to the anterior superior spine of the ilium; the thigh seems shortened; and the head of the bone may be felt on the dorsum ilii. The patient walks well, but with a peculiar rolling motion. There is little to be done in the way of treatment beyond the use of mechanical supports.

DISLOCATIONS OF THE PATELLA are not frequently met with. They may, however, occur in four directions, viz., *outwards*, *inwards*, *edgewise* or *vertically*, and *upwards*.

1. The dislocation **Outwards** is the most common variety of the accident; the bone being thrown upon the outer side of the external condyle of the femur, with its axis directed somewhat backwards and downwards, so that the inner margin is directed forwards, but sometimes the outer border is the more prominent. The knee is flattened in front, and is broader than usual; the patella can be felt in its new situation, and the muscles that form the quadriceps extensor are rendered tense, more especially the vastus internus; the leg is sometimes extended, but more frequently the knee is slightly flexed. This accident usually happens from sudden muscular contraction, especially in persons who are knock-kneed. In some cases it has been occasioned by direct violence, driving the bone out of its position. Most frequently, the patella is only partially displaced outwards, with some rotation of the bone in the same direction.

Holthouse (*Lancet*, vol. ii., 1872) has recorded a case of *congenital* dislocation of the patella outwards. The abnormality was met with in a boy aged seven, who had been admitted into the Westminster Hospital for fracture of the left femur. Whilst putting up the fracture, it was observed that the right patella was so displaced that its inner articular facet rested on the outer condyle, and that when the knee was flexed the dislocation became complete. There was no inclination inwards of either knee. The mother alleged that the condition had existed from birth, and that at first both knees were affected. The boy could run and jump as well as other children, and was not more liable to fall than they.

2. The dislocation **Inwards** is very rare; Malgaigne, who has investi-

gated this subject, is of opinion that there is only one case of the kind on record.

In these lateral dislocations, *Reduction* may be effected by laying the patient on his back, bending the thigh on the abdomen, and raising the leg so as to relax the extensor muscles. The Surgeon then, by pressing down that edge of the patella which is furthest from the middle of the joint, raises the other edge, which, being tilted over the condyles, is immediately drawn into position by the action of the extensors.

3. A remarkable form of dislocation of the patella is that in which this bone becomes twisted upon its axis in such a way that it is placed **Vertically,** one of its edges (usually the outer) being fixed between the condyles, and the other projecting under the skin, and pushing this forwards into a distinct tumor. In some cases, as those of Woolf and Mayo, the bone has been turned almost completely round, the posterior articular surface becoming partly anterior. The signs of this dislocation are evident, manual examination indicating the vertical displacement of the patella, with a deep depression on each side. The limb is completely extended, flexion being impossible.

This peculiar dislocation is of very rare occurrence, there being not more than about fourteen cases on record. It has most generally arisen from sharp blows or severe falls upon one edge of the patella, whilst the limb has been semiflexed, in consequence of which the bone appears to have been semirotated and fixed in its new position. Violent muscular contraction, however, conjoined with a twist of the leg, but without any blow, has been known to produce it in some cases.

The *Reduction* of this displacement has sometimes been very difficult; in other cases it has been readily effected; whilst in two or three instances it has been found to be quite impracticable; Surgeons having ineffectually attempted, by means of elevators and the section of the tendons or of the ligamentum patellæ, to replace the bone, and the patient having eventually died from traumatic suppuration of the joint, with the displacement unrelieved. The cause of this difficulty of reduction is not very distinctly made out; it is certainly much greater than can be explained by simple muscular contraction, and may not improbably be owing to the aponeurotic structures which cover the bone becoming twisted or entangled under it, or, as Malgaigne supposes, to the superior angle of the bone being wedged in the *subcondyloid* space. If relaxation of the muscles of the thigh, and the employment of proper pressure upon the patella, do not succeed, reduction may perhaps be effected by the patient making a sudden and violent muscular effort at extension of the limb, or by attempting to walk. In other cases the bone has been readily replaced by bending the leg, and rotating it on the axis of the tibia, at the same time that the patella is pressed into position, as Vincent recommends. Upon the whole, forcible flexion of the knee appears to have answered better than any other method, and under chloroform will probably seldom be attended by difficulty. Should these plans not answer, I do not think it would be advisable to have recourse to subcutaneous section of the tendon of the quadriceps extensor and of the ligamentum patellæ. In one case in which both these structures were divided, the patella remained as firmly fixed as ever, and the patient eventually died of suppurative inflammation of the knee-joint: and in no case in which division has been practised does it appear to have facilitated reduction.

4. Dislocation of the patella **Upwards** can only occur in consequence of the rupture of its ligament. This accident, which is always accom-

panied by much inflammation of the joint, requires the same treatment as a fractured patella.

Dislocations of the Knee.—This joint, owing to the breadth of its articular surfaces, and the great strength of its ligaments, is seldom dislocated. When such an accident happens, it usually arises from falls from a great height, or by the patient jumping from a carriage in motion.

The tibia may be displaced in four directions: *to either side*, *forwards*, *or backwards*. Besides these displacements, the joint is subject to a partial luxation, dependent upon displacement of one or both semilunar cartilages.

1. The **Lateral** dislocations of the tibia are the most common. They are always *incomplete*, and are usually accompanied by a certain degree of rotation of the limb outward. These displacements may either be **External** or **Internal.** In the first, the outer condyle of the femur rests upon the inner articular surface of the tibia. In the other, the inner condyle is placed upon the outer articular surface of the head of this bone. In either case, the knee is slightly flexed; there is a marked sulcus in the situation of the ligamentum patellæ; the extensor muscles of the thigh are relaxed, and the deformity of the joint indicates at once the nature of the displacement.

In these cases *Reduction* is always easy; indeed, it is occasionally effected by the unaided efforts of the patient or by a bystander. It may be accomplished by flexing the thigh upon the abdomen, then extending the leg, and, at the same time, by a movement of rotation, replacing the bones in their proper position.

2. The dislocation **Backwards** may be *complete* or *incomplete*. When it is complete, the posterior ligament of the joint is torn, the muscles of the ham are stretched, the limb is shortened to the extent of an inch and a half or two inches, and is semiflexed; the head of the tibia can be felt in the ham, and there is a deep transverse depression in front of the joint immediately below the patella.

3. The dislocation of the tibia **Forwards** is of more frequent occurrence than the last accident. In it, the lower end of the femur is felt projecting into the ham, compressing the vessels to such an extent occasionally as to arrest the circulation through the lower extremity, lacerating the ligaments, and stretching the muscles in this situation. The tibia projects forwards, its head forming a considerable prominence on the anterior part of the knee, with a deep depression immediately above it and the patella, which is rendered more evident by the relaxation of the extensors of the thigh; the leg is usually rotated somewhat inwards or outwards, and there is shortening to the extent of about two inches.

These antero-posterior dislocations are very commonly incomplete. When this is the case, they present the same symptoms, but in a less marked degree, that characterise the complete displacements.

In the *Treatment* of these dislocations, extension should be made from the ankle whilst the thigh is fixed in a semiflexed position. When the leg has been drawn down sufficiently, proper manipulation will bring the bones into accurate position; splints must then be applied, means taken to subdue local inflammation, and the joint kept perfectly at rest for two or three weeks, at the end of which time passive motion may be commenced.

Subluxation of the Knee, or "internal derangement of the knee-joint," is a more frequent accident than any of those that have just been described. It usually occurs from the patient, whilst walking, striking his toe against or tripping upon a stone, when he is suddenly seized with

acute and sickening pain in the knee, often so severe as to cause him to fall. Before doing this, however, he is conscious of having strained or otherwise injured the joint. On examination it will be found semiflexed, the patient being unable to extend the limb properly, and every effort being attended by severe pain; and the edge of the semilunar cartilage may usually be felt projecting under the skin. In the course of a very short time the joint becomes swollen, being distended by synovial secretion; and symptoms of subacute synovitis speedily appear. This accident, originally described by Hey, and since investigated by Sir A. Cooper and others, occurs in consequence of the semilunar fibro-cartilage slipping away from under the internal condyle, either before or behind it, so as to bring the surface of the condyle and that of the tibia into direct apposition. The severe pain that is always experienced is owing in all probability to the nipping of the loose folds of synovial membrane that lie within the joint—the so-called mucous and alar ligaments, and also to the great stretching of the ligaments by the partial displacement of the bones.

The *Reduction* may be effected by flexing the joint, and then, when the muscles are off their guard, the patient's attention being directed elsewhere, rapidly extending it at the same time that a movement of rotation is communicated to the leg. The evidence of complete reduction consists in the restoration of the power of extending the articulation. The synovitis that usually follows this injury requires to be treated by local antiphlogistic remedies and rest. After it has been subdued, the patient should wear a laced knee-cap, as the joint will be weak, and liable to a recurrence of the injury.

Complications.—Dislocations of the knee-joint are more liable to serious complications than those of any other articulation. Not only are the ligaments torn, and the muscles injured, but stretching, and perhaps laceration, of the popliteal vessels, followed by gangrene of the limb, may occur; or the joint may fall into a state of suppurative and destructive inflammation.

Compound Dislocation of the Knee-joint is one of the most serious injuries to which the limbs are liable; the external wound being usually large, ragged, and accompanied by the protrusion of the condyles of the femur, with much laceration of the soft structures in the vicinity of the joint. These are cases that certainly, as a general rule, call imperatively for amputation; indeed, Sir A. Cooper regards this injury as especially demanding removal of the limb. Cases, however, have occurred in which the limb has been saved. Hence, if the patient be young, and if the vessels of the ham do not appear to have been seriously injured, the wound in the soft parts at the same time not being very extensive, nor much bruised, an attempt may with propriety be made to save the joint. In a case of compound dislocation of the knee forwards in a boy, A. White sawed off the projecting end of the femur which protruded through the ham, and, bringing the wound together, succeeded in saving the limb.

The **Head of the Fibula** has occasionally, though very rarely, been displaced by the application of direct violence. Boyer and Sanson have each recorded a case of this kind. One such case has occurred to me in my practice. It happened in a gentleman about 23 years of age, who in descending an Alpine slope covered with snow, fell with one leg bent forcibly under him, so that he came down, as it were, in a sitting posture. The head of the fibula was thrown back off the articulating surface, and remained permanently in its new situation. The limb was somewhat

weakened, so that the patient could not jump, but otherwise he suffered no inconvenience. The tendon of the outer ham-string was very tense; and when I saw the case, some time after the accident, its traction effectually prevented all attempts at reduction.

Dislocations of the Ankle occur in consequence of displacement of the astragalus from the bones of the leg, whilst it continues to preserve its normal connection with the rest of the foot. These dislocations are almost invariably connected with fracture of the lower end of the fibula, or of the inner malleolus. In fact, on looking at the arched cavity into which the astragalus is received, it is evident that this bone can scarcely be displaced literally without fracture of one side of this arch. In considering these dislocations we must, in accordance with the general nomenclature of similar accidents, in which the distal part is always said to be displaced from the proximal, look upon the foot as being dislocated from the leg, and not consider the tibia as being displaced upon the foot. The direction of the dislocation must consequently be determined by the position into which the articular surface of the astragalus happens to be thrown. It is necessary to explain this, inasmuch as a good deal of ambiguity occurs in surgical writings from the same accident being described differently, according to the view taken of the part displaced. Thus, Sir A. Cooper speaks of the tibia as being dislocated at the ankle; whilst Boyer and others, regarding the foot as the part displaced, have described the same injury in directly opposite terms.

Dislocations of the foot from the bones of the leg may take place in four directions, viz., *to either side*, *backwards*, or *forwards*. In all cases, the injury appears to be occasioned either by the foot being twisted under the patient in jumping or running; or else by its being suddenly arrested by coming into contact with the ground whilst the body is carried forwards. But these twists or sprains do not necessarily occasion dislocation, and must not be confounded with that accident.

The dislocation **Outwards** is of most frequent occurrence. The inner malleolus projects forcibly against the skin. The deltoid ligament is either ruptured, or the lower end of the inner malleolus broken off; there is a depression above the outer ankle corresponding to the fracture of the fibula; and the sole of the foot is turned upwards and outwards, the inner side touching the ground, whilst the outer edge is turned up.

In the dislocation **Inwards**, which is a rare accident, and, according to Sir A. Cooper, much more dangerous than that just described, the fibula is not fractured, but the lower end of the fibula is splintered off, in an oblique manner from within outwards. The outer edge of the sole rests against the ground, and the inner side is turned up.

The *Reduction* of these lateral displacements is readily effected by simple traction on the foot, while the leg is flexed at the knee in order to relax the muscles inserted into the tendo Achillis; leg-splints with lateral foot-pieces must then be put on, or Dupuytren's splint may be applied on the same side as the dislocation, opposite to that on which the eversion of the foot takes place.

In the dislocation of the foot **Backwards**, the deltoid ligament is ruptured, the fibula probably broken in the usual situation, and the tibia thrown forwards on the navicular and internal cuneiform bones; the foot is consequently shortened, the heel rendered more projecting, and the toes pointing downwards.

The dislocation **Forwards**, in which the foot is lengthened, and the tibia thrown upon the upper and posterior surface of the os calcis, be-

hind the astragalus, is an accident so rare as seldom to have been witnessed, although described.

In the *Treatment* of these antero-posterior displacements of the ankle, traction of the foot in a proper direction, the leg being fixed and flexed upon the thigh, will readily be attended by replacement; the application of lateral splints being afterwards sufficient to keep the parts in proper position. Sometimes subcutaneous division of the tendo Achillis is necessary.

Compound dislocations of the Ankle-joint are serious and by no means unfrequent accidents, the displacement occurring in the same direction and from the same causes as the simple forms of injury.

The *Treatment* of compound dislocations of the ankle-joint must depend to a considerable extent upon the amount of laceration of the soft parts, and the condition of the bones forming the arch of the joint. If the wound in the soft parts be moderate in extent, clean cut, and with little bruising and injury to the bones, an attempt should be made to save the limb. This is here done by the assiduous use of antiseptics. There is no class of joint-injuries in which this method has been attended by better success than in these. The details should be carefully attended to as given at pages 216 *et seq.* Should antiseptics not be at hand, the case must be treated on ordinary principles, viz., by rest on a splint, the closure of the wound, and application of ice or cold evaporating lotions. In many instances this plan will suffice, and the patient will recover with a stiff but useful limb, the joint being only partially ankylosed.

If, however, the bones be projecting and comminuted, and the soft parts extensively lacerated, the question of amputation will necessarily arise. In many cases, the operation may be avoided by adopting the treatment recommended by Hey, of sawing off the malleoli, removing splinters of bone, cleaning the wound, bringing together its edges by simple dressing, and supporting the limb at the same time upon a M'Intyre's splint. If the joint be still more seriously injured, the posterior tibial artery torn, or the foot greatly contused, and especially if the patient be aged and his constitution shattered, recourse should be had to primary amputation. I believe that the disinclination on the part of Surgeons to amputate in these cases, greatly owing to the strong expression of opinion by Sir A. Cooper, in favor of the attempt to save the limb, has in many cases been carried to such an extent as seriously to add to the patient's danger. Secondary amputation may be rendered necessary in consequence of gangrene, erysipelas, or extensive suppuration.

Dislocations of the Astragalus.—The astragalus is occasionally displaced from its connection with the bones of the leg above, and with those of the tarsus below, being thrown either *forwards* or *backwards*. The displacement forwards happens far more frequently than that in the opposite direction. In the dislocation **Forwards**, the head of the bone may be thrown either *outwards* or *inwards;* but I do not think there is any evidence to show that complete lateral dislocation of this bone can occur irrespective of displacement forwards; the so-called *lateral* dislocations being displacements of the bone forwards, with twists to one or the other side. The dislocation *forwards*, with lateral inclination, may either be *complete* or *incomplete*. When it is *complete*, the bone is thrown out of its bed on the calcaneum, and separated from its connections with the malleolar arch above and the scaphoid in front, being forced in front of the tarsus, and lying upon the scaphoid and cuneiform bones. When the dislocation is *incomplete*, the head is separated from the scaphoid,

and is thrown up on it, or on the external cuneiform or cuboid bones, the body of the astragalus maintaining its connections with the malleolar arch and os calcis. The dislocation **Backwards** is, I believe, always *complete*. In the luxation backwards there is no rotation of the bone, which is thrown directly behind the tibia, in the space between it and the tendo Achillis.

These dislocations invariably happen from falls upon or twists of the foot; more particularly when it is extended upon the leg. When the foot is in this position, the lower end of the tibia either breaks off on the application of sufficient violence, or the head of the astragalus is forced out of the cavity of the scaphoid and its bed on the os calcis; the particular kind of displacement that occurs depending upon the direction in which the force is acting and in which the foot is twisted. And, as the foot is more frequently twisted inwards, the head of the astragalus is thrown outwards. Dislocation of the astragalus differs from dislocation of the foot in this—that when the foot is dislocated, the astragalus, though thrown out from under the malleolar arch, preserves its connections with the rest of the tarsus; whilst these are always broken through when the astragalus is the bone dislocated, even although it have not completely escaped from between the malleoli.

The dislocation of the astragalus *forwards*, with twist of the bone *inwards*, is said to be of most common occurrence: I have, however, more frequently witnessed that form of accident in which the bone is thrown somewhat *outwards* as well as forwards. In either case the displaced bone forms a distinct tumor upon the instep, in the outline of which the form of the astragalus can be distinctly made out. Over this, the skin is so slightly drawn as often to appear to be on the point of bursting. When the bone is thrown somewhat inwards, the foot is turned outwards, and the internal malleolus projects distinctly. When the astragalus is thrown *outwards*, displacement of the foot inwards, with great projection of the lower end of the fibula takes place. In some cases, fracture of the neck of the astragalus is conjoined with these dislocations; and not uncommonly the luxation is compound from the very first, or speedily becomes so if left unreduced, in consequence of the sloughing of the skin which covers the anterior surface of the bones, the exposed portion of which undergoes necrosis, and perhaps eventual exfoliation.

The dislocation *backwards*, into the hollow under the tendo Achillis, is rare, there being but seven recorded instances of this accident. In the majority of these there was displacement of the bone *inwards*, as well as backwards. In these cases the diagnosis is easy, as the bone forms a distinct prominence, which can be felt under the tendo Achillis.

In many cases the dislocation of the astragalus is not altogether complete, a portion of the bone still intervening between the under surface of the tibia and the upper surface of the os calcis.

Treatment.—The reduction of the dislocation *forwards*, whether attended by lateral displacement or not, varies greatly in facility; in some instances being effected with the greatest possible ease, in others being attended by almost insurmountable difficulties. This difference depends, I think, on whether the dislocation is complete or not. When the astragalus is not completely thrown from under the arch formed by the bones of the leg, a portion of it being still entangled between their articular surfaces and that of the calcaneum, it may usually be readily reduced by relaxing the muscles of the calf, and pushing the bone back into its proper position. But when the astragalus is completely dislocated, the

upper surface of the calcaneum is drawn up under the arch of the malleoli by all the strength of the muscles that pass from the leg to be inserted into the foot. In these circumstances, in order that reduction take place, it is necessary first of all to separate the articular surfaces to such an extent as to admit of the astragalus being pushed back into its socket: this is almost impossible, owing to the great perpendicular thickness of this bone, to the extent to which it is consequently necessary to draw down the foot, and to the little purchase that can be obtained on it. In such cases, reduction has been greatly facilitated by the division of the tendo Achillis, by which simple operation the whole strain of the muscles of the calf is taken off.

If reduction be still impracticable, and the bone continue unreduced and irreducible on the dorsum of the foot, what should be done? Two courses present themselves to the Surgeon; either at once to cut down upon the astragalus and to remove it; or to adopt a palliative treatment—to put the limb at rest on a splint, to apply evaporating lotions, and to wait the result, acting according to circumstances as they develop themselves. In some rare cases, the displaced astragalus has given rise to comparatively little inconvenience; but this can seldom be expected. If the dislocation have been in the direction forwards, the skin will usually slough, and then a portion of the exposed osseous surface, which will probably necrose, may be excised, or the whole of the astragalus may be dissected out by freely exposing it, and severing its ligamentous attachments; the patient recovering with a somewhat stiffened, but still useful joint. This plan appears to be safer than excising the bone in the first instance, so soon as the dislocation has been found to be irreducible. The operation of excising the dislocated astragalus may be greatly facilitated by the exsanguination of the foot and leg by means of Esmarch's elastic bandage. The tissues are pale and the operation is bloodless, so that the Surgeon has full command over his knife, and can see exactly what he is cutting, and where.

In luxation *backwards*, the bone has not hitherto to my knowledge been reduced, except in one case which occurred in University College Hospital, and in which the tibia and fibula were also fractured. It is by no means improbable that subcutaneous division of the tendo Achillis may in future enable the Surgeon to effect reduction. The result is, however, satisfactory, even though the bone be not reduced, the patient recovering with a useful foot. If the dislocation be left unreduced, the soft parts covering the bone may slough, as happened in a case recorded by R. C. Williams, of Dublin, in which the bone was consequently extracted.

In **Compound Dislocation of the Astragalus** (Fig. 240), the rule of practice must depend upon the extent of injury. If the integuments have merely been rent in consequence of the outward pressure of the displaced bone, an attempt must be made to reduce the dislocation by the aid, if necessary, of the division of the tendo Achillis; and, if this be effected, to close the wound by the first intention. If the bone be comminuted as well as dislocated, the proper practice will be to remove the loosened fragments, and to dress the wound in the simplest manner, allowing it to heal by granulation. If the bone be irreducible, it is a question whether it should be left or dissected out. If it be left, the wound in the integuments will certainly extend by sloughing, the bone will inflame and become carious or necrosed, exfoliating in fragments, and the patient will only recover after a prolonged, tedious, and dangerous course of treatment. In these circumstances, therefore, it appears

to me that the simpler and safer plan both to limb and life consists in enlarging the wound in proper directions, so as to dissect out the irreducible astragalus, using the elastic bandage, and then bringing the articulating surfaces into contact, dressing the parts lightly, and trusting to the formation of a new joint between the tibia and the os calcis. So, also, if a simple dislocation of the astragalus become compound in consequence of the sloughing of the superjacent tense integuments, the exposed and necrosing bone should be removed in part or in whole, according to the circumstances of the case. If, together with the dislocation of the astragalus, the foot be extensively crushed, amputation may be required either at the ankle-joint or at some convenient part of the leg.

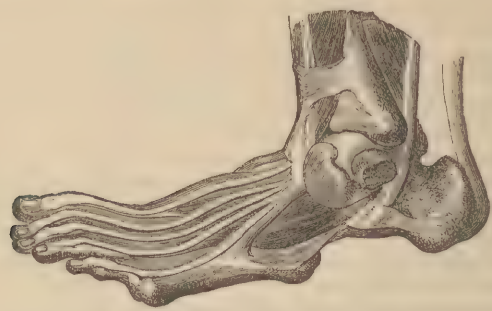


Fig. 240.—Dissection of Foot in Compound Dislocation of Astragalus outwards.

Dislocations of the other Tarsal Bones are of extremely rare occurrence. Most of these bones, however, have been found luxated at times.

The **Calcaneum** and **Scaphoid**, carrying with them the rest of the foot, are sometimes dislocated from the astragalus, which is left *in situ* under the malleolar arch. In these dislocations the bones may be displaced in either lateral direction—outwards or inwards. The *Treatment* consists in the flexion of the leg and attempts at reduction by extension of the foot in the ordinary way. If moderate extension fail in effecting reduction, Pallsel has recommended division of the tendo Achillis, and, if necessary, of the posterior tibial tendon, as a means of facilitating this, on the same principle as in dislocation of the astragalus.

The **Calcaneum** has been dislocated laterally from its connection with the cuboid in consequence of falls from a height, the sufferer alighting upon his heel. Chelius mentions a case in which this bone was dislocated by the effort of drawing off a tight boot. *Reduction* seems to be readily effected by relaxing the muscles, and pressing the bone back into its proper position.

The **Scaphoid** and **Cuboid Bones** have been dislocated upwards, in consequence of a person jumping from a height and alighting upon the ball of the foot. In these instances the limb is shortened and curiously distorted, the toes pointing downwards, and the arch of the instep being increased so as to resemble closely enough the deformity of club-foot. *Reduction* may be effected by drawing and pressing the parts into position.

The **Great Cuneiform Bone** has occasionally been found to be dislocated. Sir A. Cooper mentions an instance of the kind. If reduction be not effected by pressing the bone into its position, no great evil

appears to result to the patient, the motions of the limb not being seriously interfered with.

Sometimes the tarsal joints are extensively torn open without any one bone being distinctly dislocated. I have seen this happen to a young man who caught his foot between the spokes of a revolving wheel; the foot was violently bent and twisted, and all the tarsal joints more or less torn open. Those between the scaphoid and cuneiform bones, the calcaneo-cuboid and calcaneo-astragaloid, as well as the ankle-joint itself, were especially injured, so as to necessitate amputation.

Dislocation of the Metatarsal Bones, though excessively rare, from the manner in which these bones are locked into the tarsus, and retained by short and strong ligaments, yet occasionally occurs. Instances are recorded by Dupuytren and Smith: Liston mentions a case of luxation of the metatarsal bone of the great toe from direct violence: and Tufnell records a case of luxation downwards and backwards of the inner three metatarsal bones, from a fall upon the leg by a horse rolling on its rider. Two cases have occurred in my practice, in one of which, by the pressure of a "turn table" on a railway, the *outer* three metatarsal bones were dislocated downwards. In the other, in consequence of a horse falling and rolling on its rider, there were a compound dislocation of the first and a simple dislocation of the fourth metatarsal bone. The question of amputation will always present itself in these cases, and must be determined on general principles, by the age of the patient, and the extent of injury to the soft parts.

Luxations of the *Phalanges of the Toes* but rarely happen, and present nothing special in nature or treatment.

INJURIES OF REGIONS.

CHAPTER XXIV.

INJURIES OF THE HEAD.

Injuries of the Head are among the most important subjects that can engage the Surgeon's attention. Their importance is derived not so much from the mere injury of the scalp and skull, as from the implication of the brain and its membranes, and the results which are thereby produced, in many cases directly, and in others indirectly and remotely, owing to the anatomical connections and consequent close pathological sympathies that subsist between the external and internal structures of the head. In consequence of this tendency to cerebral complication, it is of the first moment in practice to study these injuries as a whole, with special regard to the affections of the encephalon that are produced by them, and from which the injury of the scalp and the fracture of the skull derive the greater part of their interest. It is therefore necessary,

in the first instance, to be acquainted with the nature and treatment of the principal forms of cerebral affection that supervene upon these accidents, before we proceed to study the nature and treatment of the injuries themselves.

CEREBRAL COMPLICATIONS OF INJURIES OF THE HEAD.

These may be primary or secondary. The brain is subject to three principal **Primary States of Functional Disturbance** arising from injury; viz., 1. Concussion, 2. Compression, and 3. Cerebral Irritation. Any one of these may be followed by, or be complicated with, inflammatory actions of various kinds, that derive much of their peculiar characteristics from the conditions with which they are associated, and from the injuries by which they are occasioned.

In describing these different conditions, we are compelled to define the symptoms that characterise them more distinctly than is the case in actual practice, where they are not so closely individualised, and become merged together to a considerable extent.

1. Concussion of the Brain.—Concussion, or stunning, appears to be a shock communicated to the head from the application of such external violence as will produce commotion of the substance of the brain, or interfere with the circulation through it; in consequence of which its functions become suspended, usually in a slight and transitory degree, but occasionally to such an extent that the patient does not rally for many hours from the depressed state into which he is thrown, and perhaps sinks without recovery.

The **Pathology** of concussion of the brain is very obscure. The reason of this is obvious;—few people die from simple concussion. In those cases in which death has occurred from other causes during a state of cerebral concussion, it has been found that the disturbance of the functions of the brain constituting concussion has been due to actual lesion of its substance. In some cases, the vessels of the brain and its membranes have been congested. In others, again, portions of the cerebral substance, varying in size from points to patches an inch or more in diameter, have been disintegrated and more or less ecchymosed. In the more severe and fatal cases of concussion of the brain, the cerebral substance is ecchymosed in a punctiform manner or disorganised to a great extent; in fact, in these cases the characteristic signs of contusion of the brain become apparent.

The **Signs** of concussion vary according to the severity of the injury to the brain. In the slighter cases, the patient may merely feel giddy and confused for a few minutes. In others, consciousness is not affected, but the patient feels faint and weak, and is unable to stand. In the more severe forms—in that degree, indeed, which usually accompanies any severe injury of the head—the surface of the body becomes cold and pale; the sufferer is motionless and insensible, or only answers when spoken to in a loud voice, relapsing again into speedy insensibility, or rather semi-consciousness; the pulse is feeble, the pupils are usually contracted, but may be dilated, and generally respond to the action of light, and the sphincters are usually relaxed; the limbs are flaccid, and muscular power is impaired or lost. After this condition, which is the first stage of concussion, has lasted for a few minutes or hours, according to the severity of the shock, the second stage comes on; the circulation gradually re-establishing itself, the pulse becoming fuller, and the surface warmer. About this time the patient very commonly vomits;

the straining accompanying this effort appears to be of service in stimulating the heart's action, and driving the blood with more vigor to the brain, thus tending to restore its functions; and we accordingly find that, after vomiting, the sufferer quickly rallies. In the more severe cases, the symptoms that have just been described are so strongly marked that the patient appears to be moribund; there is complete prostration of all nervous and physical power; the surface being cold and death-like, the eyes glassy, the pupils either contracted or widely dilated, the pulse scarcely perceptible and intermittent. In this state the patient may lie for hours, recovery being slow, and the concussion merging into some other and perhaps more serious affection of the nervous centres; or, indeed, in some cases, speedily terminating in death, apparently by failure of the heart's action. But it may truly be said, that every case of concussion in which unconsciousness, though but momentary, has been produced, is a most serious one. Any remote evil consequence in the form of secondary cerebral disease may possibly ensue, if once the brain-substance have been so severely shaken as to render the patient unconscious, even though the insensibility last but a few minutes. All such cases require to be closely watched and carefully managed for months after the injury.

The **Terminations** of concussion are various. We have already seen that in some cases this affection may speedily give way to complete recovery; although slight headache, some degree of giddiness, confusion of thought, and inaptitude for mental occupation, may last for a few days before the mental powers are completely re-established. In other cases, the concussion may rapidly terminate in death; but between these conditions there are several intermediate states. Thus, recovery may be complete, but a permanently irritable state of brain may be left; the patient, though capable of the ordinary duties of life, becoming readily excited by slight excesses in diet or in the use of stimulants, or by mental emotion, though not of an inordinate intensity. Individuals thus affected, suffering from a preternaturally irritable brain, frequently die suddenly in the course of a few months, or a year or two, after the receipt of the injury.

In other cases the recovery continues to be incomplete; although the patient may be enabled to follow his usual occupation, and to mix in the ordinary business of life, yet his state is precarious, the brain being liable to the occurrence of inflammatory disease on the slightest exciting cause. In such cases as these, there is frequently a certain degree of impairment of mental power, the memory failing either generally or in certain important points, as with reference to dates, persons, places, or language. The speech is perhaps indistinct and stuttering. Impairment of vision is a very common consequence of these injuries. Asthenopia, with perhaps squinting or paralysis of the eyelid, may be left. The hearing may be impaired, or noises of various kinds set up in the ears. Epileptiform convulsions occasionally occur; sometimes, as the patient is recovering his consciousness, he may be seized with a severe fit; but more commonly the convulsions do not come on as a primary consequence, but rather as a remote secondary result of the brain-injury. There may be diminution or loss of muscular and of virile power, especially, as Hennen observes, when the injury has been inflicted upon the back of the head; and Holberton has noticed that, when the medulla oblongata has been injured, the pulse may continue preternaturally slow—an observation which I have had several opportunities of confirming in injuries both of the medulla, the pons Varolii, and the crura cere-

bri. For these symptoms to occur, it is by no means necessary that the original local injury should have been severe. In some cases, the whole nervous system appears to be jarred and concussed without any wound or apparent sign of external injury to the head. At first, the symptoms of concussion are but slight, perhaps even none are apparent, and the sufferer congratulates himself on his escape; but gradually impairment of nervous power, manifesting itself in one or other of the ways just mentioned, comes on, and the health continues broken through life.

In other cases, again, the symptoms of concussion may gradually terminate in those of compression; and not unfrequently the reaction that comes on, passing beyond the bounds that are necessary for the re-establishment of the healthy functions of the brain, terminates in inflammation. Hippocrates has truly observed, that no injury of the head is too trivial to be despised, or to serious to be despaired of.

2. Compression of the Brain.—This is a common condition in injuries of the head, arising from a great variety of causes:—from the pressure of a portion of bone, of blood extravasated, or of pus formed within the skull, or from a foreign body lodged there. In whatever way occasioned, however, the symptoms, although presenting some differences, are tolerably constant. The patient lies in a state of coma, stupor, or lethargy, being paralysed more or less completely, heavy and drowsy, or insensible, not answering when spoken to, or only when addressed in a loud voice, and perhaps shaken at the same time. The breathing is carried on slowly and deeply, with a stertorous or snoring noise, and usually a peculiar blowing of the lips. The stertor appears to be owing to paralysis of the velum pendulum palati, which, hanging down as an inanimate curtain, is thrown into vibrations during expiration by the passage of the air across it; the distension of the cheeks and blowing of the lips are due to the muscular paralysis of these parts. One or both pupils are dilated; the pulse is full, often slow, the fæces pass involuntarily from paralysis of the sphincter ani, and the urine is not uncommonly retained from paralysis of the bladder; the skin may be cool, but in many cases, on the contrary, is rather hot and perhaps perspiring; the temperature may arise to 106° F. Not unfrequently this condition of stupor alternates with paroxysms of delirium, or of local convulsive action. This state of coma may become complicated by symptoms of inflammation: and, unless the cause that produces the compression be removed, it usually terminates speedily in death, the patient gradually sinking into more complete unconsciousness, and dying in an apoplectic condition. In other, but much rarer cases, the coma may continue almost an indefinite time, for many weeks or even months, until the compressing cause is removed, when the patient may recover consciousness, and the symptoms suddenly disappear.

The **Diagnosis** between *concussion* and *compression* has been sufficiently indicated in the preceding description not to require special mention here. But it must be remembered that, in many cases, one state merges into the other, so that the symptoms are not so distinctly marked as has been indicated; and they are more especially obscured when associated with inflammation.

3. Cerebral Irritation.—The third form of primary cerebral disturbance which is met with in injuries of the head, differs very remarkably from both the preceding. The patient presents symptoms neither of concussion nor of compression, nor is there any combination of the phenomena characterising these two states; but the symptoms are alto-

gether peculiar. For convenience of description, they may be divided into two groups, the *bodily* and the *mental.*

The **Bodily Symptoms** are as follows. The attitude of the patient is peculiar and most characteristic:—he lies on the side, and is curled up in a state of general flexion. The body is bent forwards, the knees are drawn up on the abdomen, the legs bent, the arms flexed, and the hands drawn in. He does not lie motionless, but is restless, and often, when irritated, tosses himself about. But, however restless he may be, he never stretches himself out nor assumes the supine position, but invariably reverts to the attitude of flexion. The eyelids are firmly closed, and he resists violently every effort made to open them; if this be effected, the pupils will be found to be contracted. The surface is pale and cool, or even cold. There is no heat of head. The pulse is small, feeble, and slow, seldom above 70. The sphincters are not usually affected, and the patient will pass urine, when the bladder requires to be emptied; there may, however, though rarely, be retention.

The **Mental state** is equally peculiar. Irritability of mind is the prevailing characteristic. The patient is unconscious, takes no heed of what passes, unless called to in a loud tone of voice, when he shows signs of irritability of temper or frowns, turns away hastily, mutters indistinctly, and grinds his teeth. It appears as if the temper, as much as or more than the intellect, were affected in this condition. He sleeps without stertor.

The course taken by these symptoms is as follows. After a period varying from one week to three, the pulse improves in tone, the temperature of the body increases, the tendency to flexion subsides, and the patient lies stretched out. The mental state also changes. Irritability gives way to fatuity; there is less manifestation of temper, but more of weakness of mind. Recovery is slow, but, though delayed, may at length be perfect; although in these, as in all other cases of cerebral disturbance, ulterior consequences may be manifested.

This form of cerebral disturbance may, from the peculiar irritability that characterises it, be with propriety termed *cerebral irritation.*

The symptoms that have just been described usually follow blows upon the temple or forehead, and probably in many cases may arise from, or are associated with, lacerations of the cerebral substance, more especially of the grey matter.

Contusion of the Brain.—The substance of the brain may be contused or lacerated by blows upon the head. This is most common at or under the seat of injury, or it may occur as the result of *contrecoup*, at an opposite point in the same, or even in the opposite cerebral hemisphere. Being struck on the right side of the head, the patient may suffer from contusion of the opposite part of the left hemisphere, or *vice versâ*, or a blow on the occiput may occasion laceration of the anterior part of both lateral lobes. In this injury of the cerebral substance, we have many of the symptoms that are characteristic of cerebral irritation; but in addition to them there is occasionally more or less coma, in consequence of extravasation of blood, or there may be paralysis, facial or hemiplegic. In other circumstances, or possibly associated with these conditions, there may be convulsive movements more or less epileptiform in character. These may be confined to the face, may extend to the paralysed limbs, or may occupy both sides of the body.

The *Prognosis* in these cases is serious, but by no means necessarily fatal. In fact, in the majority of instances, recovery ensues.

Effects of Cerebral Injury on the Mental Powers.—The mental condition of patients who are recovering or who are supposed to have recovered from head-injury, is one that deserves attentive consideration. It will frequently be found that the mental powers are weakened, either generally or in one special direction. The memory may be impaired for words, persons, or dates. The mind cannot grasp a subject or carry out a continuous train of thought, and is incapable of fixed attention or reasoning. Delusions of various kinds may occur, especially in connexion with the mode of occurrence of the accident. I have known a patient to give the most consistent and detailed accounts of the mode in which his head was injured, varying them from day to day; and every one being false, but believed in by the patient at the time. The patient could be led, by a process of questioning and suggestions combined, to give almost any version that the interrogator desired; and this with great circumstantiality of detail. This is a matter of much interest and importance in a medico-legal aspect, as it is evident that an individual who has sustained a severe injury of the head might, in perfect good faith, give an entirely false account of the mode of infliction of the injury, by which an innocent person might be seriously compromised.

The **Secondary Consequences** of injury to the brain consist of, 1, Inflammation; and 2, the Deposit of Pus and other inflammatory exudations upon or within that organ and its membranes.

1. Traumatic Encephalitis.—Inflammation of the brain and its membranes from injury (*Traumatic Encephalitis*) is an affection of great frequency and of corresponding importance. It is specially apt to supervene on all injuries of the head; though the liability to it necessarily increases with the severity of the accident. This inflammation of the brain and its membranes may set in with great intensity, the symptoms of phrenitis being strongly marked: in other instances, it gradually creeps on in a slow and insidious manner, not attracting attention until it has given rise to some severe and ulterior consequences, as effusion or suppuration, when its symptoms become so mixed up with those of compression and of irritation, as to make the exact diagnosis of the patient's condition far from easy. The period at which symptoms of inflammation of the brain may manifest themselves, after an injury of the head, varies greatly. In some instances they set in almost immediately the patient has recovered from the effects of the concussion; the reaction from this state gradually assuming an inflammatory character. In other cases, it is not until after several days that inflammation declares itself; and, again, it sometimes happens that the inflammatory affection does not supervene for weeks or months: but then, occurring perhaps under the influence of comparatively trivial causes, it may destroy the patient.

Pathological Changes.—After death, we usually find both the brain and its membranes inflamed. The arachnoid is, however, the structure that appears principally to suffer, being thickened, so as to become milky and semi-opaque. Adherent lymph of a greenish-yellow color and opaque purulent appearance, covers one or both hemispheres of the brain, being deposited in largest quantity at the seat of the injury, and not unfrequently extending across and into its fissures, occupying especially the depressions about its base. The vascularity of the brain and its membranes is greatly increased; the arachnoid being reddened in patches, and the vessels of the pia mater becoming turgid and very numerous, forming a vascular network over the surface of the brain.

The sinuses also are distended with blood; the cerebral substance exhibits an increase in the number of red points, so as often to present a somewhat rosy hue; and the ventricles are filled with reddish semiturbid serum, a large quantity of which is effused about the base of the brain. In some of the more advanced cases, inflammatory softening of the cerebral substance may occur.

Symptoms.—In considering the symptoms of traumatic encephalitis, it is useless to endeavor to make a distinction between the inflammation of the brain and that of its membranes; the two structures being always more or less implicated at the same time. The most practical division of this disease following injury, is into the *acute* and the *chronic* or *subacute encephalitis*.

Acute Encephalitis usually comes on within eight-and-forty hours of the infliction of the injury. The patient complains of severe, constant, and increasing pain in his head; the scalp is hot, the carotids beat forcibly, the pupils are contracted, the eyes intolerant of light, and the ears of noise; the pulse is full, vibrating, and bounding; and wakefulness, with delirium, usually of a violent character, speedily comes on. All the symptoms of severe constitutional pyrexia set in at the same time.

Under active and proper treatment, this condition may gradually subside until the health is re-established, but more commonly the symptoms of inflammation merge into those of compression: the delirium becoming replaced partly or entirely by stupor, from which the patient is roused with difficulty, the pupils gradually dilating, the breathing becoming heavy and stertorous, the pulse sometimes continuing with its former rapidity, at others becoming slow and oppressed. The skin is hot but clammy; the patient falls into a heavy, dull, unconscious state, which alternates with convulsive twitchings or jerkings, and occasional delirious outbreaks. As death approaches, the sphincters become relaxed, the pulse more feeble, the surface cooler, and the coma more intense and continuous, until the patient sinks from exhaustion and compression conjoined. In cases of this kind, pus may be found upon the surface or within the substance of the brain, in one case being diffused, in the other collected into a more or less distinctly circumscribed abscess. In other cases, again, the symptoms of compression appear to be induced by a thick layer of lymph lying upon the surface of the brain, or by a quantity of serous fluid being poured out into the ventricles and about the base.

Chronic or **Subacute Encephalitis** is the most interesting and important variety of inflammation following injuries of the head. It may come on a few days after the infliction of the injury, or not until months have elapsed. It may arise from accidents that simply indicate the skull, as well as from those that directly affect the brain and its membranes. The patient in many cases has apparently recovered entirely from the accident, though in others it will be found that some one symptom indicative of the brooding mischief still continues, such as headache, or impairment of sight or of hearing. Occasionally, the coming mischief is foreshadowed by unusual irritability of temper, by loss of mental vigor, or by some other functional disturbance of the brain. In such cases the subacute encephalitis may suddenly come on, ushered in perhaps by an aggravation of the persistent symptom, or by an epileptic fit. In other cases, the symptoms set in suddenly without any warning, but usually with much intensity, and speedily prove fatal.

The *Symptoms* of subacute encephalitis, when it has fairly set in, consist of those of inflammation, irritation, and compression of the brain conjoined; in some cases one, in other instances another, of the condi-

tions appearing to predominate. The irritation and inflammation proceed from the increased vascular action; the compression from the effusion of serous fluid, or pus, or of lymph. The symptoms consist of pain in the head with heat of the scalp, and either dilatation or contraction of the pupils, occasionally one being dilated and the other contracted. Squinting, intolerance of light, delirium, moaning, or screaming, unconsciousness, with convulsive twitchings of the limbs and face, commonly occur with the ordinary symptomatic fever; and lastly symptoms of coma, rapidly terminating in death.

In the subacute encephalitis, the same appearances are very generally found after death, as in the more acute form of the affection; but commonly the arachnoid membrane is principally affected. So constantly is this the case, that some Surgeons have proposed, and not altogether with injustice, to apply the term *arachnitis* to this form of traumatic encephalitis, looking upon the inflammation of the arachnoid as the principal lesion.

2. Intracranial Suppuration.—This may be of three distinct kinds: —*a.* Subcranial; *b.* Intrameningeal; *c.* Cerebral.

a. The **Subcranial** form consists in the deposit of pus between the skull and the dura mater. It always occurs at the point struck, and is limited or circumscribed. It is never the result of *contrecoup.*

Three conditions may lead to this variety of intracranial suppuration.

α. A blow on the head which, with or without wound of the scalp or fracture of the skull, causes a separation of the dura mater from the bone, leaving a cavity in which inflammatory effusions and eventually pus collect.

β. A blow on the head causing necrosis of the bone, either by simple severe contusion, or by detaching it from the dura mater and stripping off the pericranium—thus disturbing its vascular connections, and so giving rise to suppuration under the injured portion of bone.

γ. The irritation of splinters of the inner table in cases of ordinary depressed or of punctured fractures of the skull, causing chronic inflammation of the dura mater and eventual suppuration. In these cases it is often found associated with one or both of the next varieties.

b. The **Intrameningeal** form consists in the accumulation of pus, or of greenish puriform lymph, in the cavity of the arachnoid, or in its deposit in the pia mater. It is usually widely diffused, most generally beneath the part struck; but sometimes on the opposite side of the head, always more towards the vertex than in any other part. It commonly occurs in persons of low vitality—in pyæmic cases—and is associated with typhoid symptoms.

c. The **Cerebral** form is usually met with as a distinct circumscribed abscess in the white substance of the hemispheres, often associated with the last variety, and occurring in individuals of low or unhealthy habit of body. It may occur:—1. At the seat of injury; 2. By *contrecoup;* or, 3. It may be the consequence of the lodgment of foreign bodies in the brain.

The formation of pus within the skull is a sequela of much interest in injuries of the head; and an endeavor has been made, especially by Pott, to lay down the rules by which its occurrence may be accurately determined. Thus it has been said that if, during the continuance of encephalitis, fits of shivering come on, followed by the gradual supervention of coma, which slowly becomes more and more complete, whilst the constitutional symptoms of inflammation do not subside; and if, at the same time, a puffy swelling form upon the uninjured scalp, or the wound,

if there be one, become pale and cease to discharge, the pericranium separating from the bone, which is seen to be yellowish brown and dry, an abscess will have formed under the skull; and further, that in all probability its seat will correspond to those changes in the scalp and pericranium, which are due to the bone having lost its vitality by being separated from the dura mater by the subjacent abscess.

In many cases, doubtless, this progression of constitutional symptoms, accompanied by the two local signs just mentioned, has afforded proof of the existence of intracranial suppuration. It but seldom happens, however, that the signs attending the formation of pus within the skull occur in the distinct order and with the degree of precision above stated. In the great majority of cases, the Surgeon can only suspect the presence of pus from the symptoms of inflammation terminating in paralysis or coma. But he cannot say with certainty that pus has formed, for the coma may arise from the pressure of other effusions: but if the puffy swelling of the scalp or the separation of the pericranium occur, with exposure of dry and yellow bone, with hemiplegia on the opposite side, then he may feel himself justified in giving a more positive opinion as to its existence in some situation within the cranial cavity, probably beneath or in the immediate neighborhood of the part thus affected.

Pyæmia, with its characteristic visceral secondary abscesses, is by no means an unfrequent complication of injuries of the head. It may occur as a consequence of any lesion of the scalp, skull, or brain, in which the patient survives sufficiently long for the development of the characteristic phenomena of this disease. Hence it is chiefly after the slighter forms of cerebral injury that pyæmia and secondary abscesses have been met with; occasionally after wounds of the scalp, rarely after those of the brain or its membranes, but more commonly and not unfrequently after injury of the skull, more especially after severe contusion of the bone without fracture.

The sequence of pathological phenomena in these cases is the same that is observed in all in which pyæmia follows injury or wound of the osseous structures. The part of the bone that is struck usually necroses; inflammation and suppuration are set up in the surrounding portions of the skull; the cancelli of the diploë become filled with pus; its veins, which are large and sinuous, inflame, and become the media of transmitting septic material to the general circulation; the ordinary constitutional symptoms of pyæmia develop themselves, and secondary abscesses eventually form in the lungs, liver, and joints, with lowly organised plastic effusions into the serous cavities, more particularly those of the pleura and pericardium. The older writers on Surgery had noted and had marvelled at the strange phenomena of hepatic abscess following slight head injuries, and had generally overlooked the occurrence of secondary deposits in other organs and structures. More modern investigation has shown that these abscesses are pyæmic, that they are a part of a general purulent infection of the system, and that they almost invariably are accompanied by pulmonary abscesses: indeed, it is these and not the hepatic that are the common consequences of pyæmia resulting from cerebral injury. Of eighteen cases, P. Hewett found the lungs studded with abscesses in thirteen, and the liver in three; and of these three, in one case only was the liver alone affected. It has been supposed by some that intracranial suppuration is a necessary precursor of these secondary abscesses: that it frequently co-exists is undoubted—we often meet with pus in these cases between the dura mater and the contused bone; but to suppose that it is a necessary concomitant, is an

error. I have seen cases in which the most extensive secondary deposits were found in the lungs, liver, joints, &c., but in which not a drop of pus existed in the interior of the skull in any part; but I have never seen a case in which the diploë around the injured bone did not contain pus sometimes diffused through its cells, sometimes filling its venous sinuses.

When intracranial suppuration co-exists with secondary pyæmic deposits, the symptoms of the two conditions become so mixed up as to lead to considerable difficulty in diagnosis; but when the intracranial suppuration is not established, there may be a complete absence of all cerebral disturbance, whilst the alternating rigors and heat of pyæmia, the oppressed breathing, or the hepatic tenderness, with hiccup or recurring sickness, and the articular tenderness, give unmistakable evidence of the formation of secondary abscesses.

The prognosis of these cases is necessarily most unfavorable. I doubt much whether recovery is possible when once pyæmia, consequent on head injury, has advanced to the formation of secondary visceral abscesses.

Treatment.—The treatment of these various cerebral injuries, and of their concomitant affections, is one of the most important and difficult subjects that can arrest the Surgeon's attention; the difficulty depending in a great measure on the various conditions that have just been described not occurring in practice with that amount of distinctness and particularity by which their characters can alone be conveyed in description, but being associated together in such a way that the exact state of the patient cannot so readily be made out. There are few cases, indeed, in which practical tact and a nice discrimination and analysis of symptoms are more required than in those now under consideration. It would, however, be useless to attempt to describe the shades and modifications of treatment required in the management of the different groupings of these various forms of traumatic cerebral disturbance. We must, therefore, content ourselves with describing the treatment of each state broadly and separately, and leave the consideration of the varieties that commonly present themselves in practice to the discretion of the Surgeon.

In the **Treatment of Concussion**, the first great indication is to re-establish the depressed energies of the circulation and of the nervous system. In effecting this, we must be careful not to overstimulate the patient. The safest practice is that which is applicable to the treatment of shock generally;—to wrap the patient up warmly in blankets, to put hot bottles around him, or to employ frictions to the surface, and, when he is sufficiently recovered, to allow him to swallow a small quantity of warm tea. Alcoholic stimulants of all kinds should be avoided; unless the depression of the nervous energy be so great that reaction cannot be brought about without their agency. But an enema containing some ether or aromatic spirits of ammonia may be administered.

When reaction has come on, steps should be taken to prevent the occurrence of inflammatory mischief. If the concussion have been slight, it may be quite sufficient to purge the patient well, and to keep him quiet on a regulated diet for a few days, directing him carefully to avoid all alcoholic stimulants and mental exertion for some time If the concussion have been more severe, and if the symptoms of reaction have been accompanied by indications of continuous cerebral disturbance, or have been followed by giddiness, headache, or confusion of thought, the safer plan will be to adopt immediate steps for the prevention of further mischief. Venesection used formerly to be extensively practised as a pre-

cautionary measure, in order to prevent undue reaction and inflammatory mischief following on head-injuries. Perhaps our predecessors erred in the too frequent and liberal use of the lancet in these cases—I believe that Surgeons of the present day are too sparing in its use. In the young and robust the best possible effects follow venesection in head-injuries, to the extent of from 12 to 16 ounces. In children, leeches advantageously take the place of the lancet. The patient should be freely purged, kept on a low diet, and, above all, should remain quiet in bed for some days.

Should impairment of the mental faculties or senses be left, the more prudent plan will be to have recourse to a mild antiphlogistic treatment, consisting of leeching, cupping, blistering, the introduction of a seton in the nape of the neck, purging, and more especially a mild mercurial course, with strict avoidance of all mental and bodily stimulation. The patient must be carefully watched, and kept under proper supervision for some length of time, as serious symptoms are apt suddenly to declare themselves.

When **Acute Inflammation of the Brain or its Membranes** has come on, at whatever period after the injury, active treatment should be at once adopted. The head must be shaved, and an ice bladder kept constantly applied. Bleeding from the arm, repeated as often as the pulse rises, as well as by cupping, or leeches, should be had recourse to; the bowels should be freely opened, and rigid abstinence must be enjoined, the patient at the same time being confined to a quiet and darkened room, and removed from all causes of excitement of the special senses. Calomel should then be administered, so as speedily to affect the mouth. As the disease assumes a chronic form, the same general plan of treatment, modified according to the intensity of the inflammatory affection, must be persevered in, the patient being kept for a length of time after the subsidence of all the symptoms in a state of complete quietude.

The **Subacute Encephalitis** which occasionally follows injuries of the head, even at a remote period from their infliction, is most dangerous and unmanageable, being very apt to terminate in loss or impairment of the senses, in diminution of intellectual power, or in local paralysis. Much of the difficulty in its treatment appears to arise from the fact that the inflammation is often of a low asthenic type, consequently not admitting active depletory measures.

In this disorder the best results are obtained by the proper administration of mercury and the employment of counter-irritants. The best mode of administering the mercury is to give half a grain or a grain of calomel every four or six hours until the gums are affected, and to keep up the effect by diminishing, but not leaving off the drug. The repeated application of blisters over the shaven scalp is perhaps the most useful form of counter-irritation; to which, in more chronic cases, a seton in the neck may be added. So long as any symptoms of inflammation continue, this plan of treatment must be steadily kept up.

The treatment of **Cerebral Irritation** will require to be varied in different stages of this condition. In the early stage, the treatment that I have found most successful is of a negative character, and consists in the avoidance of all active measures. No good, but much harm, may result from bleeding, purging and mercurialising the patient. Complete rest, the removal of all mental and sensual excitement, shaving the head, the application of ice, a mild aperient or an occasional enema, are all that can be done in the way of medical treatment. As the constitutional

powers are depressed, they must not be too much lowered by complete abstinence from food, and small quantities of stimulants may usually be advantageously given. A tea-spoonful of brandy in a little water, or beef-tea, every hour or two, according to the condition of the pulse and the temperature of the skin, will generally be required. In some cases, where there is great restlessness, and some delirium, without any sign of encephalitis having supervened, chloral will be found of great value, or an opiate even may be given to quiet the patient and induce sleep. This cerebral irritation is the only form of primary cerebral disturbance in which I have seen opiates act beneficially; but their administration requires great care, and must not be ventured on if there be any elevation of temperature or quickness of pulse. After a time these signs of depression give way to those of subacute meningitis, the patient becomes noisy, shouting and crying, restless and sleepless. At this period, and in such circumstances, venesection may be practised with great advantage. The bleeding should be followed up by the administration of bromide of potassium or of chloral, and ultimately by the more special treatment of meningeal irritation.

In all cases of **Coma from Compression,** the pressure must be relieved before it can be expected that the coma will subside. But, besides this great and obvious indication, which must be carried out in different ways according to the nature of the compressing cause, there are certain general considerations to be attended to, by which the patient's condition may be much relieved. Thus the bowels should be freely opened by placing a drop of croton-oil, mixed with a little mucilage, in the patient's mouth, or by the use of oleaginous or terebinthinate enemata. The urine is to be drawn off twice in the twenty-four hours, the room darkened and kept quiet, and ice or an evaporating lotion applied to the head.

When symptoms of compression occur as the result of *inflammation inside the skull*, the treatment becomes surrounded by difficulties. If, notwithstanding that antiphlogistic measures have been pushed to their full extent, rigors occur and coma supervene, conjoined with a certain amount of continuous inflammatory action, the question will always arise as to whether trephining should be had recourse to on the supposition of matter having formed. In these cases two great difficulties present themselves; the first has reference to the existence of pus within the skull, and the second to its situation.

The question as to the actual existence of **Pus within the Skull,** and to the dependence of the symptoms of coma upon the compression exercised by the purulent deposit, is always a difficult one to decide. There are, as has already been stated, no absolute and unequivocal symptoms indicative of the formation of pus within the skull; symptoms closely simulating those that accompany its presence being often produced by the effusion of serum, or of puriform lymph, on the brain or its membranes. But although there may not be any symptoms that unequivocally indicate the formation of pus in this situation, the Surgeon is not unfrequently enabled, by the assemblage of general symptoms and local signs, to indicate its existence with considerable accuracy. In these cases, however, it is usually impossible to determine the exact seat of the purulent deposit with sufficient precision to admit of its evacuation by the trephine—whether the pus be between the skull and the dura mater, between the layers of the arachnoid, underneath this membrane, between the cerebral convolutions, or deeply seated in the substance of the brain; whether it be situated under the seat of injury

and be there circumscribed, or so extensively diffused as not to be capable of complete evacuation. That these difficulties are real, must be obvious to every practical Surgeon; and in illustration I may mention the following two cases, out of many that I have witnessed.

A man was admitted into University College Hospital with an extensive lacerated wound of the scalp, denuding the pericranium. He continued free from all cerebral disturbance until the tenth day after the accident, when he complained of headache, and had a quick pulse and a hot skin. At this time it was observed that the denuded pericranium had separated from the skull. He was treated by active antiphlogistic means, the symptoms subsiding, and went on favorably until the thirty-fourth day, when suddenly he became delirious and unconscious, though easily roused when spoken to loudly, and then answering rationally; his pulse fell to 48. He died on the thirty-ninth day, comatose. On examination after death, the pericranium was found detached at the seat of injury; under this the dura mater was thick, yellow, and opaque, but no pus was observable. On separating the hemispheres, however, a large abscess was found situated deeply in the anterior lobe on the injured side and protruding into the median fissure. It contained about one ounce of pus. In such a case as this trephining would evidently have been useless; for, although it was probable that there was pus within the skull, yet its seat could not have been diagnosed, and the abscess could never have been reached.

Another case that was admitted into the Hospital, was that of a man who had received a large lacerated wound on the left side of the scalp in consequence of a fall. There was no injury to the bone, and the patient went on perfectly well until the seventy-seventh day, the wound having cicatrised. He was then suddenly seized with hemiplegia of the right side, from which he recovered partially on being bled; some twitching of the muscles, however, continued. On the ninety-ninth day after the accident he became comatose, and was trephined by S. Cooper, but without relief, dying with symptoms of compression of the brain on the third day after the operation. On examination thick yellow lymph was found, covering the whole of the upper surface of both hemispheres, lying between the arachnoid and pia mater, and extending into the sulci between the convolutions. There was an abscess in the substance of the brain on the surface of the right hemisphere, on the side opposite to the seat of injury. Here also, though the symptoms were well marked, and the diagnosis as to the existence of pus correct, trephining was useless, as the pus could not be evacuated. These cases serve to indicate the difficulties that surround any operation with the view of evacuating matter from within the cranium.

When, however, the symptoms of inflammation have been interrupted by an attack of rigors followed by coma, or accompanied by hemiplegic paralysis on the side opposite to the seat of injury, with the formation of a puffy swelling of the scalp, or by the separation of the pericranium and the exposure of yellow and dry bone at the bottom of the wound, there can be little doubt that the Surgeon, though bearing in mind the extreme uncertainty of the case, might be justified in trephining at the seat of local change or of injury, in the hope of finding and evacuating pus deposited beneath the skull, and thus giving the patient his only chance of life. And indeed, if the *local* changes just described be well marked, the bone being dry, having lost its vitality, and not bleeding from the diploë when cut, the probability of finding pus immediately beneath the trephine aperture, and seeing it well up by the side of the

instrument as the bone is perforated, is very great. And should it not be met with there, and the dura mater appear bulging, and without pulsation—for the absence of the ordinary pulsatile movement of the brain is an important diagnostic sign in these cases, indicating abscess either under the dura mater or in the brain substance—an incision might even be made through this membrane, in the hope that, the abscess being circumscribed, the escape of the pus might be facilitated. Should this attempt fail, there are few Surgeons who would have the hardihood to follow the example of Dupuytren, who plunged a bistoury in the substance of the brain, and thus luckily relieved the patient of an abscess in this situation. Yet, even though pus be actually found under the skull, between it and the dura mater, and be evacuated, I fear that the patient's chances of recovery will not be very materially increased, as the encephalitis will continue, and eventually lead to his death. In my own experience, I have never met with a case of recovery in these circumstances; and P. Hewett states that the successful termination of a case of trephining for pus within the skull, even between it and the dura mater, is all but unknown to Surgeons of the present day. Yet, in the face of this unfavorable prospect, it appears to me that trephining is the proper course to pursue. There can be no doubt from the records of surgery, that patients have occasionally recovered who have been trephined for intracranial suppuration, and, as the pus cannot evacuate itself, it is perfectly certain that death must ensue if it be not let out. As the only chance of life, therefore, is in the use of the trephine, it appears to me to be proper to have recourse to this, however doubtful may be the result.

The **Treatment of Pyæmia** from injury of the skull must be conducted on those ordinary medical principles that guide us in the management of pyæmia, from whatever cause arising. There is only one point of a purely surgical character connected with it, and it is this: Should recourse be had to trephining in cases of contusion of the cranium as a means of preventing the development of pyæmia? In answer to this, I would say that experience has not demonstrated the utility of this procedure; that it is impossible in any given case of contusion of the cranium to say whether necrosis or suppuration of the bruised bone will occur; that it is extremely difficult to limit the extent of that probable necrosis, and to remove it all by the trephine; that the operation itself is attended by grave dangers of its own, and inflicts an additional injury on the diploë; that it can scarcely be considered as likely to be attended by any benefit in rescuing the patient from the possible danger of pyæmia; and that, therefore, in the face of such uncertainties and of such possible dangers, so serious an operation as trephining the skull is not justfiable.

INJURIES OF THE SCALP.

Contusions of the Scalp from blows are of common occurrence, and present some peculiarities. However severe the contusion may be, it seldom happens that the scalp sloughs. This is evidently owing to the great vascularity and consequent active vitality of the integuments of the head. In many cases, a contusion in this situation is followed by considerable extravasation of blood, raising up the scalp into a soft-fluctuating tumor. It occasionally happens, especially in blows on the heads of children, that this extravasation gives rise to the supposition that fracture exists, owing to the edge of the contusion feeling hard, whilst

atoma = Caput succedaneum

the centre is soft, apparently from the depression of the subjacent bone. In some cases, indeed, this deceptive feeling will occur without any considerable extravasation of blood under the scalp, the depressed centre being due to the compression of the scalp by the blow that has been inflicted upon it. This I have seen occasionally in children in whom the scalp is soft and somewhat spongy. The difficulty of distinguishing between such an extravasation and a piece of depressed bone, is often so great as to mislead the most experienced Surgeons. Usually, it can be effected by feeling the smooth bone at the bottom of the soft central depression, and by an absence of symptoms of compression. But in the event of doubt, it will be safer to make an incision, and so to examine directly the state of the bone itself.

The **Treatment** of contusion of the scalp is very simple; the continuous application of evaporating lotions being usually sufficient for the removal of all effusion. In no circumstances should a puncture be made or the blood let out in any way. Contusions of the scalp in girls and young women have been followed by severe neuralgic pains in the part struck. This affection is extremely rebellious to treatment; but in two cases which I have seen, after lasting for a long time, these symptoms gradually disappeared. In such cases, incisions down to the bone are said to have sometimes been beneficial.

CEPHALHÆMATOMA.—It occasionally happens that bloody tumors of the scalp form in newly born children. either from contusion of the head in consequence of the pressure to which it is subjected in its passage; or from the bruising of obstetric instruments. These tumors, which are often large and fluctuating, are termed **cephalhæmatomata**. They may occur in two situations, either *between the aponeurotic structures of the scalp and the pericranium*, or *between this membrane and the skull itself*.

The **Subaponeurotic Cephalhæmatoma** is by far the most common variety. It usually forms a large, soft, fluctuating tumor, situated upon one of the parietal eminences, and having a somewhat indurated circumference. The tumor may usually be made to subside in a few days by the use of discutient lotions.

The **Subpericranial Cephalhæmatoma** is an injury of extremely rare occurrence; but Zeller, Valleix, and others, have determined its existence. It appears as a fluctuating tumor, without discoloration of the scalp, but with a hard elevated circle around it, and a soft depressed centre, almost communicating the sensation of a hole in the cranium. Pressure, however, gives rise to no cerebral symptoms, and enables the Surgeon to feel the osseous lamina at the bottom of the depression. These tumors are usually small, seldom larger than a walnut, and it not uncommonly happens that they are multiple. It is worthy of note, however, that each tumor is always confined to a separate bone, never passing beyond the sutures, where the adhesions are the strongest between the pericranium and the subjacent osseous structure. This affection is said to be most frequently met with in children born in first confinements, and is more common in boys than in girls; according to Bouchard, in the proportion of thirty-four to nine.

The **Pathology** of this affection has been studied by Valleix. This Surgeon found that the pericranium was separated from the bone by an extravasation of blood, and that both bone and pericranium were covered with plastic matter, but otherwise healthy. He also found that the hard circle surrounding the depression was formed by a deposit of osseous and plastic matter which bounded the extravasation. This deposit was

effected in such a way that, on a transverse section being made, the inner wall was found nearly perpendicular, whilst the outer sloped down upon the cranium, thus giving a crateriform appearance to the margin of the tumor.

The *Treatment* of this affection must be conducted upon precisely the same principles as that of the other forms of scalp-extravasation.

WOUNDS OF THE SCALP are of very common occurrence, and are more serious than corresponding injuries elsewhere, especially in persons about the middle period of life, and of unhealthy or broken constitution. Not only are these injuries more likely to be followed by erysipelas than those of other parts of the body, but the great tendency to the propagation of inflammatory mischief inwards to the encephalon, and to the complication of cerebral mischief, often accompanying comparatively slight injuries of the scalp, gives to these accidents much of their serious and often fatal character. But, though there be this danger to life in scalp-injuries, there is comparatively little risk to the scalp itself; from the abundant supply of blood which it receives from closely subjacent arteries, and its consequent great vitality, sloughing seldom occurs, even though the part be much bruised and seriously lacerated.

The **Treatment** of wound of the scalp necessarily varies somewhat according to the nature of the injury. If this be a simple cut, it will be sufficient after shaving the parts around and cleansing its interior, to bring it together with a strip or two of adhesive plaster, and to dress it as lightly as possible. If the incision in the scalp be extensive, the lips of the wound must be brought together by a few points of metallic suture, or by hare-lip pins. If there be arterial hæmorrhage, this may usually be best arrested by passing the pins across and under the bleeding vessel, and compressing this with a figure-of-8 suture. In this, as in all other cases of injury of the head, especial attention should be paid to the state of the brain; for, however slight the external wound may be, serious cerebral mischief may have been occasioned; or, at all events, the same blow that has caused the cut in the scalp, may have given rise to such functional derangement of the brain as may lead to the worst forms of traumatic encephalitis.

It more frequently happens that the scalp is bruised and lacerated as well as wounded; and very commonly that a large flap of integument is stripped off the skull, and is thrown down over the face or ear, so as to denude the bones. In these cases, advantage is taken of the great vitality of the scalp. However extensively contused or lacerated this may be, however much it may be begrimed with dirt, it is a golden rule in surgery not to cut any portion of it away, but after shaving the head and ligaturing any bleeding vessels, to wash and clean it thoroughly, and replace it in its proper position. Here it must be retained by the support of a few strips of plaster, or by the application of a suture or two at the points of greatest traction; for this purpose, thick silver-wire is better than silk or thread. The use of sutures has been deprecated by many Surgeons in injuries of the scalp, as tending to favor erysipelas; and undoubtedly much mischief will arise if an attempt be made to stitch up the wound closely, and in small wounds sutures are generally unnecessary. But in extensive lacerations, more particularly in the anterior part of the scalp, where the soft parts are stripped off, and hang over the occiput as the patient lies down, they cannot be dispensed with; and here I have never seen any but the best consequences follow their use at those points where the torn surfaces can be readily approximated. In cases of this kind, the under surface of the scalp granulates, and union by the second

intention takes place between it and the pericranium. If the edges do not come properly together, a piece of water-dressing may be applied; but the head must be kept cool, and as little bandaging and plastering had recourse to as possible. The patient should be freely purged, and kept perfectly at rest on a rather low diet; any cerebral symptoms that occur being treated in accordance with the principles laid down in discussing traumatic affections of the brain. In this way, union will very probably take place through the greater portion of the injured surface; should it not do so, however, or should any part slough, granulations spring up, and reparative action goes on with surprising rapidity. If pus form beneath the aponeurosis of the occipito-frontalis muscle, bagging must be prevented by early counter-openings, and by the employment of compression in proper directions.

It is important to make the diagnosis between traumatic erysipelas of and abscess under the scalp. This may, as a rule, be done by observing that in erysipelas the red tumefaction of the scalp extends from the margins of the wound, and early stretches beyond the true limits of the pericranium, invading the eyelids, attacking the ears, etc.; whilst in abscess, there is not only an absence of extension of disease, with the exception possibly of œdema of the eyelids, beyond the proper limits of the scalp, but the purulent collection will gravitate to certain defined parts of the head, directed by the anatomical connections of the occipito-frontalis.

The pericranial aponeurosis or tendon of the occipito-frontalis muscle is firmly attached to the fat and fascia superficial to it, whilst it is connected in the loosest manner possible with the parts underneath. This arrangement is often of great service in protecting the skull from fracture, especially when the head is caught between two solid bodies, as, for example, the wheel of a cart and the ground, when the scalp is torn off and the head slips away, so escaping further injury. In suppuration occurring under the tendon of the occipito-frontalis, the pus gravitates to the most dependent parts until arrested by the attachments of the aponeurosis. These attachments are as follow. Posteriorly, the fleshy bellies are attached to the superior curved line of the occipital bone, and the space between them is filled up by dense fascia similarly attached. Laterally, the tendon is connected with the attollens and attrahens aurem, to the mastoid process, and in front of the ear to the zygoma. Pus gravitating in this direction, therefore, forms a bag of fluid just above the zygoma, never extending into the cheek. In front, the fleshy fibres of the muscle are blended with those of the corrugator supercilii and the orbicularis palpebrarum; while in the middle line they are continued down over the nose into those of the pyramidalis nasi; and the pus will therefore collect in the upper eyelids, and in a pouch over the root of the nose.

When the wound is too tightly closed, the discharges force their way in all directions in the loose tissue under the tendon, giving rise to general puffy swelling of the head and diffused redness, often extending over the face; and it is probable that this state of things has often been confounded with erysipelas, and has given rise to the idea that stitches in the scalp give rise to that disease. If simple erysipelas supervene, that disease will require to be treated in accordance with ordinary surgical principles. So far as the wound in the scalp is concerned, that must be thrown open, all dressings removed, and, if matter form, a free outlet must be afforded to the pus. If diffuse cellulitis occur, free incisions must be made through the puffy and swollen scalp, and counter-openings for the discharge of pus and sloughs.

When the skull itself is extensively denuded in consequence of the pericranium being stripped off the subjacent bone together with a flap of the scalp, it does not necessarily follow that necrosis and exfoliation of the exposed bone will occur. The flap must be laid down on the denuded osseous surface, to which it may possibly contract adhesion through the medum of granulations. Should it, however, slough, and a large portion of the skull be even exposed, exfoliation of the outer table, though probable, does not necessarily happen; for, in some cases, instead of exfoliating, the exposed portion of the skull will inflame, plastic matter be thrown out, and granulations springing up, a covering be formed to the bone.

FRACTURES OF THE SKULL.

Injuries of the Bones of the Skull, especially Fracture, possess great interest, not so much from the lesion of the bone itself, as from its frequent complication with injury of the brain and its membranes. This cerebral complication may either be produced by direct injury, the fragments of the fractured bone compressing or wounding the brain; or it may be the result of concussion or laceration of the brain by the same violence that causes the fracture.

Bending in of the Cranial bones without Fracture is an accident that may occur in infants and young children, before the bones of the skull are completely ossified. In several instances, the displaced bone has been raised by aspiration with an india-rubber sucker. But no harm comes of leaving the bone depressed, as it will generally recover its proper level in time.

Contusion of the Cranial Bones without fracture, occasioned either by ordinary direct violence or by the oblique impact of bullets, is a very serious injury, more particularly when complicated with wound of the scalp. In it there are three sources of danger, any one of which may be followed by a fatal result, viz.: 1. Necrosis of the part of bone struck, leading to exfoliation of the outer table, or to separation of the whole thickness of the cranium and exposure of the dura mater; 2. Suppuration under the skull, between it and the dura mater; and, 3. Pyæmia with secondary visceral abscesses, in consequence of the suppuration of the diploë around the necrosed point of bone, and the entrance of pus into the cranial veins,—a condition to which reference has already been made.

The following statement, taken from the records of the War Department of the United States army, gives a good summary of the results of gun-shot contusions of the skull without fracture.

Of 328 cases, there died 55; disabled, 173; recovered, 100. The deaths arose from hæmorrhage, 2; tetanus, 4; pyæmia, 4; dysentery and fever, 8; compression from blood or pus, 17; various intracranial injuries, 22.

In 221 cases the seat of injury is mentioned with the percentage of mortality as follows:—

	Cases.	Deaths per cent.
Frontal bone	54	15
Temporal "	33	15
Parietal "	95	13
Occipital "	33	9
More than one bone . . .	6	

This shows these injuries to be most dangerous in the temporal and frontal regions, and least so in the occipital.

Of the 173 disabled, the following complications are specified as the causes of the disability:—

10 Persistent pain in the head. Vertigo, giddiness, and dizziness were some of the commonest complaints among pensioners.
23 Paralysis of limbs more or less marked.
16 Impairment of vision; wound mostly in frontal region.
14 Impairment of hearing; wounds mostly in parietal and temporal regions, but some frontal and some occipital.
9 Epilepsy.
10 Insanity.

FRACTURES OF THE SKULL are invariably the result of external violence. This may act *directly* in breaking and splintering the part struck, the fissures often extending to a considerable distance and detaching large portions of the skull; or the violence may act in an *indirect* manner, producing the fracture either without being applied immediately to the cranium, or else at an opposite part of the skull to that which is struck. Thus the base of the skull may be fractured by the shock communicated to it when a person, falling from a height, strikes the ground heavily with his feet. The variety of indirect fracture in which the lesion occurs at a point of the skull opposite to that which has been struck, is the *Fracture by Contrecoup.*

Fracture by Contrecoup has been described by some Surgeons as of frequent occurrence, whilst it has been denied by others. There can, however, be no doubt that it does happen, though less commonly, perhaps, than is generally supposed. Every hospital Surgeon must occasionally have seen unequivocal instances of it. For its occurrence, several conditions are necessary. The skull must be struck over a large surface, as when a person falls with his head against the ground. If a blow fall on a thin portion of it, this will be fractured directly; but if a dense and strong part of the bone be struck, as the parietal eminence, or the lower part of the os frontis, the shock transmitted through the skull generally will cause the thinnest and most brittle portions of it, though distant, to give way in preference to the stronger part on which the blow has immediately fallen. The fracture by *contrecoup* is most common at the base of the skull, and is usually much radiated. It is always fissured, never depressed.

SIMPLE FRACTURE.—An ordinary **simple or undepressed fracture** of the skull consists in a fissure, sometimes single, at other times starred, extending often to a considerable distance through the bones, radiating sometimes across the skull, and in other cases completely detaching its upper from its lower part, or its anterior from its posterior segment. In some cases the fracture extends into one of the sutures; and in other instances, which, however, are very rare, the sutures are separated without any fracture.

The injury usually occurs from direct violence, but is also the only form of fracture that happens by *contrecoup*. A fissure or fracture, such as this, gives rise to no signs by which its diagnosis can be effected, and often escapes detection altogether, more particularly when the scalp covering it is not wounded, or, if contused, when so large a quantity of blood is extravasated as to render it impossible for the Surgeon to feel the subjacent bone. If, however, the scalp covering the injured bone had been wounded, its existence may be ascertained by running the finger-nail, or the end of a probe, over the exposed surface of the bone, or by seeing a fissure into which the blood sinks.

As the whole importance and danger of fracture of the skull depend,

not upon the injury that the bone has sustained, but on the concomitant or secondary lesions of which the contents of the cranium are the seat, no special *Treatment* is required for the fracture itself when simple and undepressed, the Surgeon's whole attention being directed to the injury that may have been inflicted on the brain or scalp. Active precautionary measures should be adopted without delay, with the view of guarding against the occurrence of inflammation of the brain and its membranes, even though no symptoms have as yet declared themselves. So soon as the patient has recovered from the concussion, his head should be shaved, an ice-bladder applied, and blood taken from the arm; the bowels should be well opened, and the room kept cool and quiet. The employment of free and, if need be, repeated bleeding is, however, of more service than any other means, and should never be omitted, except in feeble, very young or aged subjects.

In **Chronic Hydrocephalus**, the cranial bones are thinned and expanded; but, being at the same time preternaturally elastic and mobile, they are seldom fractured. When they are so injured, the presence of the water may save the brain from the direct effects of the blow. In one case that was under my care, the hydrocephalic child fell from the top of a house on to its head, and sustained a long fracture through the left side of the skull, but without any scalp-wound. Shortly after the accident, a large soft fluctuating tumor formed under the scalp opposite the line of fracture; and, on this being tapped, about three ounces of hydrocephalic fluid were drawn off. This operation was repeated, but the child died about ten days after the injury, with hemiplegia of the opposite side, and with convulsions.

Fracture of the Base of the Skull.—The most serious, and indeed a very commonly fatal form of fissure or simple fracture of the skull, is that which extends through its *base*. It may occur in three ways. 1. This injury is usually caused by direct violence, as by a fall or a blow upon the vertex or side of the head, producing a fracture which extends from the point struck across to the base of the skull, often running through the petrous portion of the temporal bone or into the foramen magnum. 2. It may also take place as the result of *contrecoup*, the blow being received on the forehead, back, or side of the head, and the jar of the bones expending its greatest violence on and fracturing the base of the skull, and 3, by the impact of the spine against the condyles of the occipital bone causing a fracture that radiates from the foramen magnum. This kind of fracture of the bone is well illustrated by the annexed cuts (Figs. 241, 242), taken from patients of mine who fell from a height on the head. The effects will vary according to the character of the surface on which the person falls. If hard, as on stone, the vertex will be smashed in, and if there be fracture of the base, it will be occasioned in the first way. If the head strike soft ground, the body will be violently projected against the base of the skull, and this variety of fracture may be occasioned by the force of the impact; and it has occurred as the consequence of alighting on the feet from a great height, when the shock has fissured the occipital bone from the edge of the foramen magnum outwards. The great danger in these cases arises from the concomitant injury to the brain, either by direct laceration or by the extravasation of blood under it. Though most usually fatal, these injuries are not invariably so. Not only does it occasionally happen that patients with all those signs of fracture of the base of the skull, which will immediately be described, are seen to make a complete recovery, but in the different Museums specimens illustrative of recovery

after this accident may be met with. Thus, in the College of Surgeons' Museum, there is the skull of a person who lived two years after a fracture of its base.

Fig. 241.—Splintering of edges of the Foramen Magnum and Radiating Fracture of Base of Skull from Fall on Vertex.

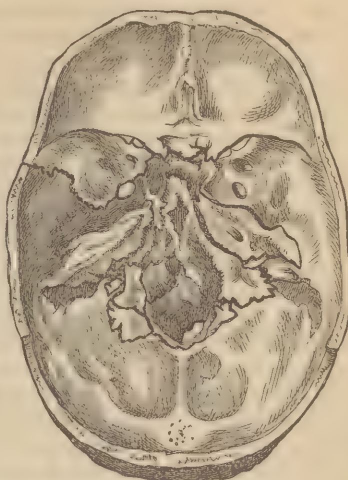


Fig. 242.—Fracture of Base by Fall on Vertex. Both Condyles broken off and driven in. Vertex was fissured.

For the mechanism of the production of fracture by counter-fissure, I would refer the reader to Haller's *Disputations Chirurgicæ*, and to the prize memoirs of the Royal Academy of Surgery, of France, by Quesnay and others.

Sir Charles Bell has some excellent and philosophical observations on this subject in his "Surgical Observations," London, 1816, p. 472, *et seq.* He concludes by these remarks: "As to counter-fissure he (the Surgeon), understanding the principle, will comprehend how a remote and weaker part of the cranium is rent when a thicker and more convex part is struck. He will not be surprised that when the stronger occipital bone is struck the temples will be sparred out, or how, these resisting, the base may be fractured. . . . and he sees that, although the reflected force be not so great as to burst the bones asunder, yet it injures the fine texture of the brain; in one instance it throws out blood upon its surface; in another it separates the dura mater; or, in a third, it covers the brain with purulent matter, and that at the part diametrically opposite to the injury of the skull."

Signs.—Fracture of the base of the skull is very commonly suspected when symptoms indicative of serious injury to the brain speedily follow a severe blow upon the head. Those parts of the nervous centre that are most important to life are more liable to injury in this than in other fractures of the skull; the same violence that occasions the fracture injuring the contiguous portions of brain, or lacerating some of the large venous sinuses at the base of the skull, and thus giving rise to abundant intracranial extravasation of blood. These symptoms are necessarily in the highest degree equivocal; and much anxiety has consequently been manifested by Surgeons to discover some special sign of the occurrence of this particular fracture.

The signs of fracture of the base of the skull will necessarily vary

according to the seat of injury. When the fissure extends through the *anterior fossa*, there may be extravasation of blood into the orbit or eyelid, or free hæmorrhage from the nose. When it implicates the *middle fossa*, there is, in all probability, fracture of the petrous portion of the temporal bone, with rupture of the tympanic membrane, and then there will be bleeding or a watery discharge from the ears. When the *posterior fossa* is the seat of injury, the signs are more equivocal, unless the fissure extend forwards to the petrous portion of the temporal bone, when the more characteristic signs will occur.

There are two signs, the occurrence of which, separately or together, leads to strong presumptive evidence of the existence of this kind of fracture. 1. The Escape of Blood from the interior of the Cranium through the ears, nose, or into the orbit; and 2. The discharge of a Serous Fluid from the ears, and occasionally from other parts in connection with the base of the skull.

1. The occurrence of **Bleeding from one or both Ears** after an injury of the head cannot by itself be considered a sign of much importance, as it may arise from any violence by which the membrana tympani is ruptured, without the skull being necessarily fractured. If, however, the hæmorrhage be considerable, trickling slowly out of the external auditory meatus in a continuous stream, if the blood with which the external ear is filled pulsate, and more especially if the bleeding be associated with other symptoms indicative of serious mischief within the head, and if it have been occasioned by a degree of violence sufficient to fracture the skull, we may look upon the hæmorrhage as strong presumptive evidence that a fracture of the base of the skull, extending into the petrous portion of the temporal bone, has taken place, and that perhaps, one of the venous sinuses in its neighborhood is torn. I have seen patients recover without any bad consequences from copious aural hæmorrhage after severe head-injury. The evidence, therefore, is only presumptive; it is not positive as to fracture of the base of the skull through its petrous portion, or indeed of any intracranial injury whatever. Copious hæmorrhage from the ear to the extent of many ounces has been known to occur from a fracture of the anterior and inferior part of the meatus auditorius externus, in consequence of the condyle of the lower jaw being forcibly driven up against it, the jaw itself having been fractured.

Hæmorrhage into the Areolar Tissue of the Orbit and Eyelid, giving rise to extensive ecchymosis of the lid, possibly with protrusion of the eye-ball itself, often accompanies fracture of the orbital plate of the frontal bone. The ecchymosis that occurs in these cases arises from the filtration of the blood from the interior of the skull, through the fracture, into the loose areolar tissue adjacent to the injured bone. It differs remarkably in appearance from that resulting from a direct blow upon the eyelid—from a "black eye." In the latter case there is bruising of the skin, and the ecchymosis is in a great measure cutaneous, of a reddish-purple color. In the ecchymosis from fracture, the hæmorrhage is entirely subcutaneous and subconjunctival: there is probably no bruising of the eyelid, but this is tense, greatly swollen, and of a purple color. The extravasation appears under the ocular conjunctiva in a very marked manner, which is rarely the case in an ordinary black eye, where the ecchymosis is superficial to the palpebral ligament, and shut off from the subconjunctival areolar tissue. This hæmorrhage may be venous or arterial. When venous, it probably arises from laceration of the cavernous sinus. When arterial, it may, as Hewitt has shown, be the forerunner

of a circumscribed traumatic aneurism of the orbit, attended by pulsation, bruit, and projection of the eyeball, requiring the deligation of the common carotid for its cure.

Bleeding from the Nose or Mouth may of course arise from any injury of these parts without the skull being implicated; yet in some cases of fracture of the skull the hæmorrhage proceeds from the interior of the cranium, through a fissure in the roof of the nasal fossæ; it then indicates a fracture through the ethmoid and sphenoid bones. In a patient of mine who died five weeks after an injury of the head, accompanied by bleeding from the nose, a fracture occasioned by *contrecoup* was found extending across one orbital plate of the frontal bone, and separating its articulation with the ethmoid. In this case, the nature of the injury was suspected from the fact of the nose itself having been uninjured by the blow, although the hæmorrhage from it was very considerable and continuous; for it is in the quantity and duration of this hæmorrhage that its value as a diagnostic sign of fracture of the base of the skull consists.

Vomiting of Blood may occur in these cases, from the blood having found its way through the fractured ethmoid or sphenoid down the nose and through the posterior nares into the pharynx and stomach. In these cases the vomited blood is dark, grumous, and mixed with the contents of the stomach. In some rare cases, the blood that issues from the nose and mouth passes into these cavities through the Eustachian tube. The petrous portion of the temporal bone is fractured, and the middle ear opened; the tympanic membrane, however, being unbroken, no bleeding from the external ear ensues, but the blood escapes into the pharynx through the Eustachian tube. In some cases there may be a combination of these different signs. Thus, in a patient of mine at the Hospital, there were hæmorrhage into the left orbit and from the left nostril, copious vomiting of blood, and bleeding from the right ear, following a blow upon the forehead. The diagnosis which was made during life, and which was verified after death, was a fissure of the skull extending through the left orbital plate of the frontal bone, the ethmoid, and probably the sphenoid on that side, and a fracture of the petrous portion of the right temporal bone.

2. The **Discharge of a thin Watery Fluid** from the interior of the skull sometimes occurs; and, when it happens, it is the most certain sign of the fracture of the base that we possess. This discharge usually takes place through the ear; but it may occur from the nose, of which I have seen one instance, and Robert mentions another. Still more rarely it takes place from a wound in the scalp communicating with the fracture; percolating through this, and so being poured out externally. Cases of this kind have been described by Hey, O'Callaghan, Robert, Hewett, and other Surgeons. One such instance was communicated to me by one of the pupils of University College, a few years ago. A boy received a wound on the back of the head, with depressed and comminuted fracture of the skull. On the nineteenth day after the receipt of the injury, a large quantity of serous fluid began to escape through the wound, and continued to do so profusely until his death from coma four days later. At first the fluid that is discharged is usually tinged with blood, but this soon ceases, and it then flows clear.

There would consequently appear to be three situations—the ear, the nose, and a wound on the vault of the cranium—from which this discharge has been observed. It is an exceedingly valuable though most serious sign; and Robert, who has investigated this phenomenon with

much closeness, states that the cases in which it happens always terminate fatally. This, however, is an error; for a number of cases have occurred at the University College Hospital and elsewhere, in which the patients, adults, recovered, although many ounces of fluid were discharged from the ear. It is usually associated with symptoms indicative of serious injury to the base of the brain; but to this there are also exceptions, for I have seen it in cases of injury to the head, unaccompanied by any severe cerebral symptoms. Most generally it occurs in young people. Robert says that it does so invariably; but Hewett states that in most of the instances in which he has seen it the patients were above thirty years of age. In one of the cases that I have witnessed, the patient was fifty-eight years of age; and in six other instances in which I have observed it, the patients were all adults. In all cases of recovery that I have witnessed, some deafness of the ear from which the discharge occurred has been left; but the hearing, though usually lost, does not always appear to be destroyed in the ear from which the discharge takes place.

The *Quantity* of fluid that is thus discharged is always very considerable, the pillow usually becoming soaked by it, which may be the first thing to attract attention to it. It is often necessary to keep a piece of sponge or a pledget of lint against the ear, in order to prevent the fluid from wetting the patient as it trickles out; and, if a cup be so placed as to collect it, an ounce or two will speedily accumulate. Laugier states that he has seen a tumbler full discharged in a short time, and as much as twenty ounces have been known to be poured out in three days. The flow is usually continuous for several days, and then ceases.

Although the occurrence of a watery discharge from the ear after certain injuries of the head had been observed by Van der Wiel, O'Halloran, and Dease, in the early part and middle of the last century, no attention was paid to the subject by later surgical writers; and the subject appears to have been completely lost sight of until Laugier, in 1839, again directed the attention of Surgeons to this interesting phenomenon. Since this period, it has been often observed and attentively studied; and the nature and the source of this discharge have been particularly investigated by Laugier, Chassaignac, Robert, Guthrie, and Hewett. Its *physical and chemical characters* are those of a perfectly clear, limpid, and watery fluid, containing a considerable quantity of chloride of sodium, with a little albumen in solution, and some sugar. It is not coagulable by heat nor by nitric acid.

The **Source of this discharge** has been the subject of much speculation. Laugier believed it to be the serum of the blood filtered through a crack in the petrous portion of the temporal bone, and so through the ruptured membrani tympani. This explanation, however, is evidently not correct; for not only is blood extravasated in the living body incapable of this species of rapid and complete filtration, but the fluid differs altogether in chemical composition from the serum of the blood, in containing a mere trace of albumen and double the quantity of chloride of sodium. By others it has been supposed that the fluid is furnished by the internal ear, being a continuous discharge of the liquor Cotunnii; but its large quantity, and, above all, the fact of its occasionally escaping through the nose, demonstrate the fallacy of this explanation. Again, it has been supposed, but without sufficient evidence, that the cavity of the arachnoid furnishes this secretion. But the arachnoid does not secrete sufficiently to furnish the quantity of fluid discharged; and if this membrane were irritated and the secretion increased, it would

become opaque from lymph or pus admixed with it. I think, with Robert, that there can be little doubt that this discharge, in most cases at least, consists of the cerebro-spinal fluid; for not only is it, in appearance and chemical composition, identical with this liquid, but there is no other source within the skull than the pia mater which can yield with equal rapidity so large a quantity of fluid; experiment on animals having shown that the cerebro-spinal fluid is rapidly reproduced after its evacuation. An additional point of analogy between this discharge and the cerebro-spinal fluid is to be found in the fact pointed out by C. Bernard, that they both contain a small quantity of sugar. In order that the fluid be discharged, the membranes of the brain must have been torn opposite the outlet by which it is poured forth. This has actually been ascertained to be the case, by carefully conducted dissections. When it is discharged through the ear, the laceration, as Bérard has remarked, must have extended through the cul-de-sac of the arachnoid, which is prolonged around the auditory nerve in the internal auditory canal. When it is poured out through the nose, the fracture has probably extended through the cribriform plate of the ethmoid bone, and laid open the prolongation of arachnoid that surrounds the filaments of the olfactory nerve.

The diagnostic value of watery discharge from the ear varies, according to Hewett, with its relation to the hæmorrhage which may occur. He divides cases of watery discharge from the ear after injuries of the head into three classes.

In the first class, the discharge is watery from the first, and abundant, being preceded by little or no blood, and beginning immediately after the accident. This is undoubtedly cerebro-spinal fluid, which escapes through a fracture of the petrous bone implicating the internal auditory canal.

In the second class, there is copious and prolonged bleeding from the ear, followed by the watery discharge. Here, too, there is fracture of the petrous bone: but its exact situation is uncertain. In these cases, the diagnosis will rest upon the prolonged hæmorrhage, rather than on the watery discharge.

In the third class, there is but little bleeding after the injury, and the watery discharge, which is variable in quantity, varies also in the time of its appearance. In these cases the diagnosis must remain doubtful. He mentions two cases which occurred at St. George's Hospital in which a copious watery discharge flowed from the ear. In neither of these after death was any fracture of the petrous portion of the temporal bone found. In one the membrana tympani was ruptured, and the cavity of the tympanum was "intensely vascular;" in the other, "the discharge was connected with a fracture of the lower jaw just below the condyle: the lower fragment had perforated the wall of the meatus auditorius."

The facial nerve may be so injured by a fracture of the petrous portion of the temporal bone as to become paralysed at the time of the accident. But more frequently paralysis of this nerve does not come on until a later period, about the second or third week after the injury, and disappears after lasting about a month. This transient facial paralysis accompanying some forms of fracture of the base of the skull has been studied by Marshall, who ingeniously explains it as being occasioned by the pressure of plastic effusions, which gradually become absorbed as the fracture unites, and thus the compression of the nerve is removed after a time.

Treatment.—The treatment of fracture of the base of the skull must be conducted on those general principles that guide us in the management of simple fractures of the cranium, such as ice to the shaved head, a calomel purge, low diet, and absolute quietude in a darkened room. In most cases, the brain is so injured in its most vital parts that speedy death is the result. When recovery takes place, it is necessarily slow and protracted, liable to retardation from meningitis of an acute or subacute and chronic character.

Depressed Fracture of the Skull.—It occasionally though very rarely happens that, in consequence of a blow, a portion of the skull is depressed without being fractured, and even without any serious cerebral symptoms occurring. Such depression without fracture can, however, only occur in children, whose skulls are soft and yielding. In adults it cannot happen without the occurrence of partial or incomplete fracture. Many, if not all, of the so-called "congenital depressions" that are met with in the skull are the result either of violence inflicted on the cranium at birth, usually in instrumental labors, or of falls and blows upon the head in early infancy. Such depressions are smooth, concave, and sometimes symmetrical, and present very different characters from the irregular outline of an ordinary fracture. They never present the characters of a fissure; there is no such thing as a congenital fissure of the skull.

In the **Diagnosis** of depressed fracture, it is important to remember that the apparent depression produced by an extravasation under the scalp may simulate this injury very closely; for even an experienced Surgeon may sometimes in these circumstances be induced to cut down on a suspected fracture, when in reality none exists. This happens in consequence of the blood that is extravasated coagulating round the circumference of the contusion, whilst that which is in the centre remains fluid, so that a very deceptive sensation of a hollow with a hard rim is communicated to the finger.

Varieties.—Depressed fractures of the skull may either be simple, without wound of the scalp; compound; or comminuted. In the majority of cases, whether the fracture be simple or compound, there is comminution of the bone; the fragments being perhaps driven into the brain.

Sometimes, though very rarely, the **external table** alone is depressed and driven into the diploë. This is especially the case over the frontal sinuses, where it may be broken in, as I have seen happen from the kick of a horse, without the inner table being splintered, or any bad consequence ensuing.

The **inner table** may be fractured without any apparent injury to the outer table; and it may not only be so fractured, but a portion of it may be depressed, without the outer table being injured (Figs. 245, 246). Of this remarkable injury twenty cases are recorded as having happened in the late American war. One recovered, the diagnosis being made by finding the splintered inner table in a sequestrum which was removed. The rest died of intracranial mischief, and the diagnosis was not made during life.

More commonly, when the inner table is thus fractured or depressed, the outer table is fissured. In all ordinary depressed fractures, the internal table is splintered to a greater extent than the external one. This is especially the case when the fracture is the result of gun-shot injury, or when it has been occasioned by blows with a pointed weapon, as the end of a pick, or a large nail, or the sharp angle of a brick. In these

fractures, which constitute the dangerous variety termed **Punctured,** the outer table may be merely perforated or fissured, whilst the inner one is widely splintered into numerous fragments, for the extent of a square inch or more. This splintering of the inner lamina of the skull to a greater extent than the outer one has attracted much attention, being of considerable practical moment, and is usually said to be owing to its being more brittle than the external table. This, however, I do not consider to be the only cause. I should rather attribute it to the fracturing force from without inwards losing a certain amount of momemtum in passing through the outer table; the inner table being thus splintered more widely than the outer one, for the same reason that the aperture of exit made by a bullet is larger than that of entry. If this be the true explanation, the reverse ought to hold good if the force be applied in the opposite direction. It is very seldom that we have an opportunity of examining such a case; but, some years ago, a man was brought to the Hospital who had discharged a pistol into his mouth and upwards through the brain. The bullet had perforated the palate and passed out at the upper part of the cranium, near the vertex On examining the state of the bones, it was found that the outer table of the skull was splintered to a considerably greater extent than the inner one, showing clearly the influence of the *direction* of the fracturing force (Figs. 243, 244). This case led me to make further experiments on the dead body; and I found that the outer table is always more splintered when the blow is struck from the inside of the skull outwards.

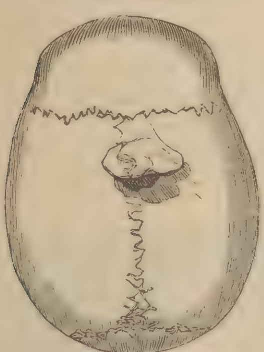


Fig. 243.—Fracture of the Skull from Gun-shot Injury from ~~wound~~: Splintering of Outer Table. within

Fig. 244.—The same—natural size.

Teevan has made a considerable number of ingenious experiments on this subject, by firing bullets and driving pointed bodies of various kinds through the skull. He finds, as the result of these investigations, that the aperture of exit is the larger, whether the blow be delivered, or the bullet be driven from without inwards, or the reverse. The explanation at which he has arrived is, that the aperture of entry is caused by the penetrating body only, whilst the aperture of exit is caused by this *plus* the fragments of bone driven out of that table of the skull which was first perforated. Thus, when a bullet strikes the external table from without, it first perforates this, and then carries along with it and through the inner table the fragments of bone that it has cut out of the external table, and hence fractures the inner table more widely than the outer. When both sides of the head are traversed by a bullet, it will

be found that the aperture of entry in the *outer* table on the side first struck, and the aperture of entry in the *inner* table of the opposite side of the head will be the smallest, the largest holes made by the bullet being the apertures on the inner table of the former side and the outer table of the latter. In the case of a large and broad body like a bullet, which carries and does not merely perforate bone, Teevan's explanation is doubtless correct. But, in the ordinary "punctured" fracture, made, for instance, by the point of a nail being driven through the skull, it must be remembered that no fragments of the outer table or diploë are carried onwards, and that the very wide-spread splintering of the inner table, which is characteristic of this form of injury, cannot be accounted for in this way, but appears to me to be referable to the cause I have given—viz., the *direction* of the fracturing force and the loss of momentum in the breaking body.

It occasionally happens, as the result of sabre- or hatchet-cuts on the head, that a longitudinal incised fracture occurs, in which the outer table is merely notched, whilst the inner one is splintered along the whole line of blow. In other cases, again, a portion of the skull is completely sliced off, hanging down in a flap of the scalp, and exposing the brain or its membranes.

A special and very important kind of punctured and depressed fracture is that in which, by the thrust of a stick, umbrella, or other blunt-ended body into the orbit, the orbital plate of the frontal bone, or the cribriform lamella of the ethmoid, is perforated, and the dura mater or brain wounded. In such cases there is sometimes no external wound, the stick having passed up under the upper eyelid; and it is conceivable that the same result might even be produced by a thrust up the nostril. Death results either from wound of the cavernous sinus and intracranial extravasation of blood, or more remotely from the secondary inflammatory effects of the wound of the dura mater and brain.

It is very important to observe that *the inner table may be very extensively fissured, fractured, and depressed, without any fracture of the outer*

Fig. 245.—External Table Slightly Depressed.

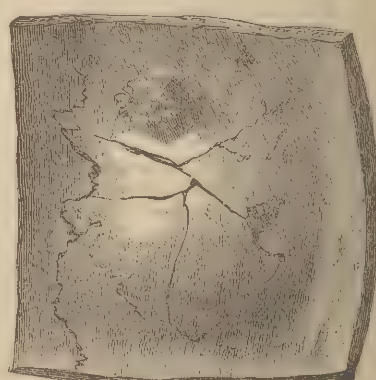


Fig. 246.—Internal Table Depressed and Fissured.

table. The accompanying cuts taken from photographs of a preparation in the Army Medical Museum, Washington, represent a case of extensive fracture with depression of the inner table of the left parietal bone from gun-shot without fracture of the external table.

The patient was struck obliquely on the side of the head by a musket-ball, which inflicted a scalp wound. There was no sign of cerebral disturbance until two days after the injury, when symptoms of compression set in. The skull was carefully examined through the wound for fracture; none could be found. The symptoms of coma increased and proved fatal on the tenth day, when the inner table of the left parietal bone was found extensively starred and depressed (Fig. 246), without any fracture of the outer table (Fig. 245). There was a wound of the dura mater and an abscess on the cerebral hemisphere—in fact, all the appearances and sequences of an ordinary "punctured fracture." This interesting case demonstrates clearly the possibility of extensive fracture with depression of the inner table, whilst the outer remains unbroken.

The **Symptoms** of a depressed fracture of the skull are of two kinds: those that are dependent upon the injury to the bone, and those that result from the concomitant compression or laceration of the brain.

When the scalp is not wounded, the depression may sometimes be felt; but very commonly it is masked by extravasation of blood about it, and the Surgeon is only led to suspect its existence by the continuance of symptoms of compression from the time of the injury. In all cases of doubt, when these symptoms exist, an incision should be made through the scalp at the seat of injury, and the state of the skull examined. When there is a wound in the scalp communicating with the fracture, the Surgeon detects at once the existence of depression and comminution by examining the bone with his finger through the wound. When the fragments that are depressed are impacted and firmly locked together, so as to form an unyielding mass, symptoms of compression of the brain, to a more or less marked degree, usually result. But if the fracture be very extensive, and the fragments, though somewhat depressed, lie loose, and if they be yielding and do not exercise a continuous pressure on the brain, it occasionally happens that no cerebral disturbance comes on for some days, even though the injury be very extensive. A man twenty-four years of age was admitted into University College Hospital. He had been struck on the forehead with the sharp edge of a quoit. The frontal bone was extensively comminuted, twelve fragments being removed, and the dura mater being exposed to a considerable extent; yet no bad symptoms occurred until the ninth day, when inflammation of the brain and its membranes set in, and he speedily died.

In other cases again, more especially in children and young persons, in whom the bones are soft and yielding, fracture with depression may exist to a considerable extent, and no symptom whatever of compression be produced at any time—the patient living with a portion of his skull permanently beaten in. I have several times seen persons in after-life with large flat depressions of the skull, the result of injuries sustained in childhood, who presented no signs of cerebral disturbance. It is very rare, however, to meet with a recent case of depressed fracture in the adult without signs of compression of the brain. But, though rare, it is not impossible; and Green mentions the case of a man whose skull was depressed to the extent of the bowl of a dessert spoon, without any symptoms of compression.

Wounds of the Dura Mater.—The great danger in these cases of depressed and comminuted fracture arises not only from the compression of the brain, but from the rapidity with which inflammation is set up in consequence of the sharp fragments wounding and irritating the mem-

branes and brain. Indeed, a wound of the dura mater, however slight, is a most dangerous complication. This is more especially the case in those injuries in which the inner table is extensively splintered, as in the different forms of punctured fracture. In these cases there may be no signs of compression; but inflammation speedily sets in, and certainly proves fatal if the cause of irritation, the sharp spicula of bone, be allowed to remain in contact with the dura mater. This membrane becomes sloughy, and coated with a thick deposit of plastic matter, whilst the usual evidences of encephalitis are found in the other membranes and the brain. Wounds of the dura mater, though in the highest degree dangerous, are not necessarily fatal. In military practice it has often happened that, as the result of sabre-cuts, portions of the skull have been sliced or split down, the subjacent membranes and the brain itself being wounded, and yet a good recovery has resulted; and I have had several cases under my own care in which, though the dura mater has been punctured by spicula of depressed fractures, and portions of brain lost, the patients have made good recoveries.

The **Treatment** of a depressed and comminuted fracture of the skull varies not only according to the nature and extent of the accident, but also to the existence or absence of symptoms of compression of the brain.

If there be no wound in the scalp, but the occurrence of symptoms of compression and the existence of some irregularity of the skull at the seat of injury lead the Surgeon to suspect a depressed fracture, he should make a crucial or T-shaped incision down upon the part in order to examine the bone, and, if this be found depressed, he should elevate or remove it.

If the scalp be already wounded, all that need be done to ascertain the nature of the fracture, is to pass the finger very gently into the wound and thus examine the bone. If any fragments be found lying loose, they should be picked out, as they can only excite injurious irritation; any bone that is driven below its level must be raised, and, if completely detached, removed.

Fig. 247.—Application of Elevator.

In order to raise these depressed portions of bone, it is in many cases merely necessary to introduce the point of an elevator underneath the fragment, and, using the instrument as a lever, raise it into position (Fig. 247). If there be not an aperture sufficiently large for the introduction of the elevator, one may be made by sawing out an angle of bone at a convenient spot by means of a Hey's or cranial saw (Figs. 248, 249), or clipping off a projecting point with the bone-forceps. The instrument familiarly known as Hey's Saw does not appear to have been invented, though it was largely used and described, by Mr. William Hey, of Leeds. He states ("Practical Observations on Surgery," London, 1814, p. 9), that the instrument was first shown him by Dr. Cockell, of Pontefract, and that a saw, formed on the same principle, is represented in Scultetus' Armamentarium Chirurgicum. In the works of Ambrose Paré (edited by Malgaigne, Vol. II., p. 14), will be found an exact representation of the instrument, with a straight edge, as depicted by Hey, and as used at the present day. He

says: "Par icelle on peut couper de l'os (sans comprimer dessus) tant ou si peu qu'on voudra, sans estre en danger de comprimer l'os fracturé sur les membranes et par consequent sur le cerveau." In this way, sufficient space may usually be gained without the necessity of applying the trephine. If, however, the inner table be splintered to a considerable extent, or if there be no convenient angle that can be removed, the tre-

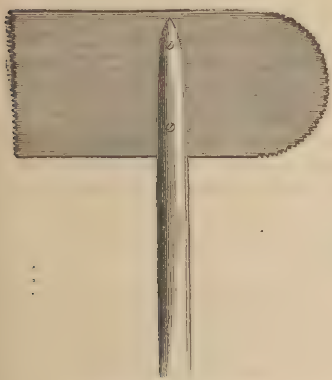


Fig. 248.—Hey's Saw.

Fig. 249.—Application of Cranial Saw.

phine must be applied in such a way that at least half its circle is situated upon the edge that overhangs the depressed bone; the Surgeon sawing out by means of this instrument a portion of the undepressed skull, in order that he may more conveniently get at the fragment. After a half circle of bone has been removed in this way, the depressed splinters may be taken out, a Hey's saw still being occasionally required before the whole can be removed; the flaps of scalp should then be laid down, a suture or two applied, and water-dressing put over the wound. Rigorous treatment must then be adopted, with the view of preventing or removing inflammatory symptoms

From the success that has attended the treatment of depression of the skull without fracture, by means of pneumatic traction, it has been recommended in cases of simple depressed fracture, without injury of the brain or its membranes, to make an attempt to draw the depressed portion of bone to its normal level by means of a cupping-glass, adapted to the uneven surface of the skull by means of a cell of glazier's putty.

In all cases of **Punctured Fracture**, where there is but slight injury of the external table, with considerable splintering and depression of the inner one, or where there is a narrow and deep depression of the bone, the trephine must be applied on different principles from those that guide us in its use in ordinary depressed fractures. In the punctured fracture it is applied, not to remove symptoms of compression which, in all probability, may not exist; but with the view of preventing the inflammation which will to a certainty be set up if the splinters of the inner table be allowed to continue irritating the membranes and brain. Hence it is a rule in surgery, in all cases of punctured fracture, to apply the trephine at once. In these cases a trephine with a large crown should be used, and the circle of injured bone itself must be sawn away (Fig. 250). Should, however, the use of the trephine have been delayed in these cases until inflammatory action has been set up, the instrument may still be applied with advantage. Many years ago a boy was admitted

into University College Hospital, on the sixteenth day after having been struck on the side of the head by a large nail, which projected from a door that fell upon him. No symptoms of any kind had occurred until the eleventh day after the accident, when he became dull and lost his appetite; on the sixteenth day, that of his admission, he had suddenly become drowsy and delirious, but answered rationally when spoken to, and complained of pain in the head. The pupils were dilated, the skin hot, and the pulse quick. On examination, a small round aperture, from which some fetid pus exuded, was discovered on the right parietal eminence. On introducing a probe, which the hole just admitted, some rough bone could be felt. S. Cooper immediately trephined the boy, removing a circle of bone including the small aperture. The inner table corresponding to this was found splintered to some extent, and the dura mater was thickened and inflamed; but the patient recovered without a bad symptom.

Fig. 250.—Trephined circle round Punctured Fracture. Natural size.

Linear Cuts, as by sabre or hatchet, into the skull, penetrating the outer table, are apt to splinter the inner one, in the same way as occurs in a "punctured" fracture, to which they bear a close analogy. They require the same preventive trephining that is needed in the true punctured fracture, having for its object the removal of splinters and spicula, which would infallibly produce a fatal meningitis if left.

In these rare cases in which there is a **Depressed Fracture, without symptoms of compression** or even a wound of the scalp, the rule of practice is somewhat unsettled, as to whether the depressed portion of bone should be left where it is, or an attempt be made to elevate it. Sir A. Cooper, Abernethy, and Dupuytren advised that, if it do not give rise to any symptoms of compression, it is better not to interfere with it; and there are several cases on record of patients who have recovered in whom this course was adopted, the depression continuing permanent. That non-interference is the proper course to pursue in some cases, more particularly in children, there can be no doubt. I have had under my care a child in whom, in consequence of a fall, there was on one of the parietal bones a depression as large as a crown-piece, its edges being sharply defined; no signs of compression or of inflammation of the brain ensued, and it was consequently left without interference, the child making an excellent recovery, and continuing well. Indeed, in children, the amount of injury that may be inflicted on the brain not only by compression but by actual laceration, and yet be followed by recovery, is very surprising.

In the adult, the cerebral substance does not accommodate itself so readily to injuries, and here the line of practice is not quite so definite. But even in persons of mature age, under certain favorable circumstances, bone may be depressed and continue so without giving rise either to compression of the brain or to inflammation of its membranes. I had once under my care a case which illustrated this point forcibly. The patient, a middle-aged man, fell on his head into an area, and stripped off the greater part of the scalp from the anterior part of the head and the vertex; on the upper part of the left parietal bone was a starred and depressed fracture of the skull as large as a florin. As the depression was smooth, not more than a quarter of an inch in depth, and there was no symptom of compression, I drew the scalp forwards and left the bone untouched, the patient making an excellent recovery, without any

symptom of intracranial mischief. I am also acquainted with a gentleman upwards of fifty years of age, who has a depression in the parietal bone as large as the bowl of a table-spoon, the result of a fracture by a fall from a horse when a lad, and from which no inconvenience has resulted. I think, however, that the expectant treatment should not be followed too implicitly, but that we must be guided by the circumstances of the particular case. If the depression be nearly uniform, of inconsiderable depth, and occupy a large extent of skull, which is depressed in a smooth hollow or bowl-like manner, and more especially if the patient be young and the scalp unwounded, it may be better doubtless to follow the advice of Cooper, Abernethy, and Dupuytren, and to wait for symptoms of compression manifesting themselves before we interfere. If, however, the scalp be wounded, the depression sharp, deep, and comparatively small in extent, we may reasonably suspect the existence of considerable splintering of the inner table; and here, I think, the safer plan would be, even in the absence of all symptoms of compression, to elevate for the same reason that we trephine in punctured fracture—the prevention of inflammatory action that will be occasioned by the irritation of the splinters of the inner table. I would not, however, venture to dogmatise on this very important and difficult point of practice. The opinions of the most experienced surgeons are at variance; and cases may readily be adduced on either side in support of conflicting doctrines. It would appear that military Surgeons generally are in favor of the expectant plan, and cases may be found in the works of Guthrie, Ballingall, &c., in support of this practice; and it is a remarkable circumstance that, in many of these instances in which recovery resulted in cases of depressed fracture of the skull which were not subjected to operative interference, the patients were exposed to great privations, possibly during a hurried retreat, and left in circumstances apparently the least favorable to recovery. So far as my own experience is concerned, which is necessarily drawn purely from civil practice, I can say that, with the exception of the case that has just been referred to, I do not recollect ever having seen a case recover in which a compound depressed fracture of the skull occurring in the adult had been left without operation; but I have, on the other hand, seen several instances of recovery in which the bone had been elevated and fragments removed.

The sooner elevation is done the better. Danger does not arise from early operation, but from delay. The presence of depressed and spiculated fragments pressing into the dura mater must inevitably and speedily induce encephalitis. I have several times trephined in such circumstances as these with success, and have never had occasion to regret doing so. Indeed, there is no class of cases in which the operation of trephining is attended by such successful results as in those of depressed and comminuted fracture. Even though several days have elapsed and inflammation has set in, the proper treatment will be to remove the depressed and splintered bone, and thus give the patient his only chance—a slender one, it is true—of recovery. In such adverse circumstances the patient may, however, be saved. A man was admitted under Liston with a long depressed fracture on the side of the head, produced by the blow of a brickbat; though no sign of compression existed, yet symptoms of cerebral inflammation were speedily set up, and Liston trephined him on the fourth day after the accident; the man, who was perfectly conscious, walking into the operating theatre. A considerable splintering of the inner table was found, the fragments of which were removed. The dura mater having been punctured by one of the spicula of bone,

diffuse suppuration of the membranes of the brain set in, and the patient died in a few days. In this case, however, the necessity for early trephining was clearly indicated, notwithstanding the absence of any symptom of compression.

The **Ultimate Results of Fracture of the Skull** in those who recover will less closely resemble the conditions given at p. 532, as the consequences of contusion of the cranium without fracture. Epilepsy was very frequent in the American war cases; so also partial or complete loss of vision was one of the common sequences of such injuries. When deafness occurred, it was generally connected with impairment of other special senses, and often of the mental faculties.

When a depressed fracture of the skull is **complicated with a Fracture or other Injury of the Spinal Column**, it is sometimes difficult to determine how much of the symptoms may be due to one accident, and what proportion to the other. In such a case as this, however, we should, I think, treat the depressed fracture irrespectively of the vertebral injury, thus giving the patient a chance of recovery, of prolongation of life, or, at least, of return of consciousness before death. A man was admitted under my care into the hospital, with depressed fracture of the left parietal bone, and injury of the cervical spine, the precise nature of which could not be accurately determined. He was in a state of complete coma and paralysis. I trephined the skull and elevated the depressed portion of the bone; he recovered his consciousness to a great degree, but died in a few days, apparently from injury to the spine. On examination after death, we found a fracture of the fifth cervical vertebra.

INJURIES OF THE CONTENTS OF THE CRANIUM.

WOUNDS OF THE BRAIN AND ITS MEMBRANES are frequent in injuries of the head, and are among the most important complications of these accidents. The extent of injury inflicted upon the cerebral substance has wide limits, from slight laceration without exposure, to denudation of the brain, disintegration, and escape of large portions of its substance.

Causes.—Injury to the brain may be occasioned in various ways. The simplest form is that, perhaps, which is not unfrequently met with in undepressed fracture of the skull, and sometimes happens without fracture, from simple concussion or commotion of the head; laceration of the cerebral substance occurring under the seat of injury, or more frequently at a distant or opposite point, by a kind of *contrecoup*. This *laceration of the brain by contrecoup* is by no means of unfrequent occurrence. I have seen many striking instances of it, and have found it to be one of the commonest causes of death in simple fracture of the skull. Laceration of the brain by *contrecoup* is attended by much extravasation of blood; and after death the brain-substance is found mixed up with coagula, and forming a soft, pulpy, bloody mass. In most instances that I have seen, the anterior lobes have been thus contused, lacerated, and disorganised. This accident may occur without any fracture of the skull or external signs of serious injury, and usually results from falls upon the back or side of the head, often from an inconsiderable height, as when a person slips suddenly up in frosty weather and strikes his head on the pavement; the anterior portions of the hemispheres of the brain, or the parts opposite to that struck, will then be found in the condition just described.

The brain and its membranes are often lacerated by the *sharp spicula*

of a depressed fracture, which may penetrate to a considerable depth in its substance. And, lastly, the injury may be occasioned by *foreign bodies*, such as bullets, traversing or lodging in the head; or by *stabs and punctures* through the inner portions of the skull, especially the orbital plate of the frontal bone. In this way a piece of stick, tobacco-pipe, the point of a knife, or a scissor-blade, may puncture the anterior part of the brain.

Symptoms and Effects.—The symptoms and results of wound or laceration of the brain vary greatly according to the age of the patient, the seat of injury, and other conditions, which cannot very readily be determined. If the injury implicate those portions of the nervous centre at the base of the brain, the integrity of which is necessary for the proper maintenance of the respiratory act, immediate death must necessarily ensue. If, however, portions of this organ that are less essential to life, as the anterior lobes and upper part of the hemispheres, be injured, but very slight symptoms may occur; and in some cases there is no positive indication by which this injury of the cerebral substance can be determined, except by its exposure and escape through the external wound. Hence, even the worst injuries of the head are rarely immediately fatal, the patient being seldom killed outright, unless the medulla oblongata or pons Varolii be wounded. Children, especially, have been known to bear extensive injuries of the brain, and even the loss of a considerable quantity of cerebral matter, without any very serious effects, either immediate or remote; and it is by no means uncommon to see them live several days with an extent of injury to the brain which would rapidly have proved fatal to an adult. Indeed it may be stated generally, that the younger the patient, the greater the chance of recovery. So, also, the prognosis may be considered more favorable in men of the laboring class, whose minds are but little exercised, than in persons of more cultivated intellect. Twitching of the muscles and epileptiform fits, are commonly met with when the brain is lacerated; and these, complicating coma, or alternating with it, indicate the nature of the mischief.

Foreign bodies even of large size and considerable weight have been lodged for a considerable time within the skull, in contact with the brain, without occasioning death. Thus Hennen states that he has seen five cases in which bullets were lodged within the skull, that did not prove immediately fatal. Cunningham relates the case of a boy who lived for twenty-four days with the breech of a pistol, weighing nine drachms, lying on the tentorium, and resting against the occipital bone. O'Callahan has recorded the remarkable case of an officer who lived about seven years with the breech of a fowling piece, weighing three ounces, lodged in the forehead; the right hemisphere of the brain resting on the flat part, from which it was only separated by false membrane.

From the great variety of effects produced by these injuries, it must be evident that there can be no one set of symptoms indicative of wound of the brain, provided there be no external wound through which the condition of the cerebral substance can be ascertained. In those cases in which this does not exist, we can at most only suspect laceration, if we find that the ordinary symptoms of compression or concussion are associated with signs that do not usually occur in those conditions when uncomplicated; such as contraction of one pupil, dilatation of the other, and perhaps an alteration of these states with twitchings of the limbs, hemiplegia of one side, or paralysis of an arm and of the opposite leg, with perhaps involuntary spasmodic movements of the other members.

In simple uncomplicated cerebral compression, the pupils are always dilated. In laceration of the brain without compression, they are contracted. When laceration and compression are conjoined, one pupil may be dilated and the other contracted; or both will be dilated or contracted, according as the symptoms of compression or of laceration predominate. These irregular symptoms, when accompanied by much coldness on the surface, slowness of pulse, and depression of vital power, may generally be looked upon as indicative of cerebral laceration. This effect of the cerebral lesion, whether it assume the form of paralysis or of convulsions, is always manifested on the side of the body opposite to that on which the injury to the brain exists; but not necessarily opposite to that on which the blow has been inflicted on the head; for the injury to the brain may, by counter-stroke, be in that cerebral hemisphere which is opposite to the side of the head that has been struck. Thus, if a person struck on the right side of the head sustain a rupture of the middle meningeal artery, and have extravasation of blood on the right hemisphere of the brain, he will have hemiplegia on the left side, and *vice versâ.* But, if the blow that is inflicted on the right side were to give rise to extravasation by counter-stroke on the left side of the head, the paralysis would develop itself on the side that had been struck. So it is with convulsive movements; they will occur in the arms and legs, on the side opposite to that on which the brain has been injured, whether that injury be on the side struck from direct violence, or on the opposite side from counter-stroke. In this way the hemiplegia may occur on one side, and the convulsions on the other. A man was struck a violent blow on the *right* temple. He was seized with hemiplegia and facial paralysis on the *left* side, and with convulsive movements on the *right* side of the face, the *right* arm, and leg. He died a few days after the injury. On examination, we found a fissure of the right parietal bone, laceration of the middle meningeal artery, and a large clot pressing on the *right* side of the brain: hence the hemiplegia on the *left* side of the body. There was laceration with disorganisation of the middle lobe of the brain on the *left* side: hence the convulsive movements of the *right* side of the face, body, and limbs.

Saccharine Diabetes is an occasional consequence of injuries of the brain. A man 43 years of age was admitted into Hospital under my care with paralysis, the result of a fall on the back of his head. On examining his urine, it was found to contain sugar in very large quantity. Previously to the accident, he had been perfectly well and robust; and, as the paralytic symptoms disappeared, the diabetic sugar gradually lessened in quantity, until it ceased entirely to be formed, and this notwithstanding the continued use of saccharine and amylaceous matter in the food. Claude Bernard has recorded some similar instances in illustration of the interesting physiological fact pointed out by him, that wounds of the central portion of the medulla oblongata and irritation of the fourth ventricle of the brain in rabbits occasion saccharine diabetes, and indeed, that in the dog artificial traumatic diabetes may be induced by fracture of the skull and consecutive injury of the brain.

The **Danger** of wounds of the brain varies greatly according to the part that is injured. It is greatest and most immediate in injuries of the base of the brain, of the pons Varolii, and crura cerebri; it is least and most remote when the upper and anterior part of the hemispheres is the seat of lesion.

The **Mode of Death** after these injuries varies. They may prove fatal at once, when the base is wounded, by the injury of the respiratory

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tract; in the course of a few hours, by the continuance of shock, and by the extravasation of blood within the cranium; at a later period, by the occurrence of encephalitis and its consequences; or more remotely, by the supervention of paralysis and other ulterior effects of injury of the nervous system.

The **Cerebral Nerves** are occasionally injured at their roots, or torn across and detached from their connexion with the brain, in injuries of the head. These nerves may be wounded by the same violence that injures the brain, as when a bullet traverses the head; or they may be detached from their connexion with the brain in laceration of the cerebral pulp; or, lastly, they may be torn across in fracture of the base of the skull, by the fissure extending across the foramen through which the nerve passes.

Thus, or from extravasation of blood into its sheath, blindness may result from injury to the optic nerve at any part of its course; ptosis, and strabismus in different directions, according as the third, the fourth, or the sixth nerve has been injured. But the nerve that most commonly suffers is the seventh, which, either in its facial or in its auditory portion or both, is not uncommonly torn across in fractures of the petrous portion of the temporal bone, producing either paralysis of the face or deafness.

Injury to the eighth nerve is not common, or rather it is not common for patients long to survive who exhibit evidence of the lesion. I have, however, seen repeated vomitings, with palpitations, and a sense of suffocation continuing for months after apparent injury to the origin of the pneumo-gastric. In other cases, from lesion to the spinal accessory, spasm of the trapezius and sterno mastoid muscles, simulating tetanus, may set in.

Treatment.—In the treatment of injuries of the brain, little can be done after the system has rallied from the shock, beyond attention to strict antiphlogistic treatment, though this need not be of a very active kind. In these cases, indeed, as much should be left to nature as possible, the Surgeon merely removing all sources of irritation and excitement from his patient, and applying simple local dressings.

If any foreign body be lodged within the skull, it must of course be removed, if possible. This may be done if it be situated near the external wound, or fixed in the bone; but if it have penetrated deeply into the substance of the brain, and have gone completely out of reach, it would be perhaps more dangerous to trephine the skull on the chance of reaching it, or in any other way to go in search of it, than to leave it where it is. Bullets should always be extracted if they can be found. On this point military Surgeons are agreed. If they enter the skull, and strike against and fracture the opposite side without escaping, should they be sought for? I think not. Larrey and Bell, it is true, have extracted the ball on the side of the head opposite the point of entrance. But it may not be found there. In a case of suicide to which I was called some years ago, a gentleman had shot himself through the right temple; immediately opposite the wound, on the left temple, was a raised, loose and stellate fracture of the skull, over which the scalp was uninjured. I cut down on this and removed the fragments of bone, expecting to find the ball beneath them; but in this I was disappointed, and after death the bullet was found lying in the base of the skull, where it had rolled.

Hernia or Fungus Cerebri.—In those cases in which a laceration of the brain and dura mater communicates with a fracture of the skull, it is occasionally found, more particularly in children, that a dark brown

or bloody fungus-looking mass of cerebral matter protrudes from the wound. The period after the receipt of an injury at which this protrusion takes place, varies from a few days—eight or ten—to several weeks. It has been remarked by Guthrie, and the observation has been fully confirmed, that hernia cerebri is more likely to take place through small than large apertures in the cranial bones. This tumor increases rather rapidly, pulsates synchronously with the brain, and may shortly attain the size of a hen's egg, or even become larger (Fig. 251). In its compo-

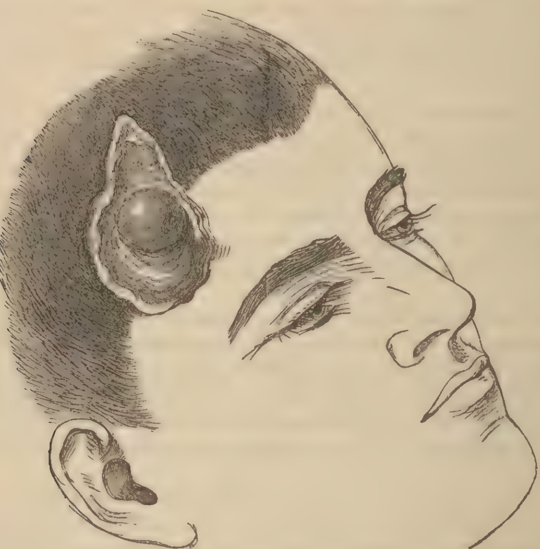


Fig. 251.—Hernia Cerebri following Compound Comminuted Fracture of Right Parietal Bone.

sition and structure it varies. In some instances it is composed chiefly, if not entirely, of extravasated blood; but the true fungus cerebri is composed of softened and disintegrated cerebral matter, infiltrated with lymph and blood. The softening of the brain, with red discoloration, extends for some little distance under the base of the tumor. The mental condition of the patient is in many cases not much disturbed at first, there being merely some degree of cerebral irritation. Speedily, however, stupor comes on, and death eventually occurs from encephalitis, followed by coma, consequent on the inflammatory effusions that take place within the skull.

Treatment.—The treatment of this complication of fractures of the skull is commonly extremely unsatisfactory. If the tumor be shaved off, as is usually recommended, it generally sprouts again until the patient is destroyed by irritation and coma conjoined. In some fortunate cases, however, the removal of the tumor is not followed by its reproduction. All that can be done is to slice off the growth on a level with the brain; to apply a pledget of dry lint, and a compress and bandage over the part, thus allowing it to granulate and the wound to cicatrise.

Extravasation of Blood within the Skull commonly occurs in all injuries of the head accompanied by laceration of the brain, and in many of those in which the skull is fractured without that organ being injured.

Indeed, when we reflect on the great vascularity of the parts within the skull, the large sinuses, the numerous arteries that ramify both within the bones and at the base of the brain, and the close vascular network extended over the surface of this organ, we can easily understand that extravasation of blood is one of the most frequent complications of these injuries and a common cause of death, when they terminate fatally at an early period after their occurrence.

Causes.—Intracranial extravasation of blood may take place either with or without fracture of the skull. When it is the result of fracture, it is in consequence of the fissure tearing across one of the meningeal arteries distributed on the inside of the skull, or of a fragment of bone wounding a sinus or the vascular network on the surface of the brain; or it may proceed from laceration of this organ breaking down its capillary structure. In other cases, as in gun-shot wounds, the hæmorrhage may be a consequence of wound of the vessels by the bullet or other foreign body; but it may also be the result of apparently trifling injuries of the head without bruise or wound of scalp, or fracture of skull, from the rupture by concussion of one of the meningeal arteries.

Sir Charles Bell ("Surgical Observations," London, 1816) has investigated and determined the method of the production of intracranial meningeal extravasations. He says: "It is extraordinary that any one who has ever raised the skull-cap in dissection, and felt the strength of the universal adhesions of the dura mater to the lower surface of the bone, could for an instant believe that the *arteria meningea media* has power of throwing out its blood to the effect of tearing up these adhesions from the entire half of the cranium!" He then describes the following experiment to show that the dura mater is first of all separated from the skull, and that the extravasation is consequent on that separation: "Strike the skull of the subject with a heavy mallet; on dissecting, you find the dura mater to be shaken from the skull at the part struck. Repeat the experiment on another subject, and inject the head minutely with size-injection, and you will find a *clot* of the injection lying betwixt the skull and dura mater at the part struck, and having an exact resemblance to the coagulum found after violent blows on the head. I imagine this is conclusive" (pp. 466—67).

Situations.—The extravasation may occur in four situations: 1. Between the dura mater and the skull, where it is most commonly met with; 2. Within the cavity of the arachnoid; 3. Upon the surface of the brain; or, 4. Within its substance and its ventricles. It is usually most considerable when poured out upon the dura mater, or within the cavity of the arachnoid at the base of the brain. It is in smallest quantity immediately on the surface of that organ, or within its substance. It is, however, seldom found in the latter situation as the result of violence, without being met with more superficially. The quantity effused in any one case seldom exceeds four ounces. I have once seen a clot from rupture of the middle meningeal artery that weighed five ounces and a half; and, when in such large quantity, it usually proceeds from rupture of the meningeal artery.

Results.—Extravasation of blood is one of the most frequent causes of death in injuries of the head, by inducing pressure on the brain and coma. The blood that is extravasated usually coagulates into a firm granular clot. There can be no doubt, however, that extravasation of blood into the membranes of the brain frequently occurs without being attended by fatal consequences. The blood that is so extravasated may undergo various changes: 1. The extravasated blood may be absorbed

entirely; 2. The serous portions and coloring matter may be removed, leaving a fibrinous buff-colored clot, which may eventually become organized; and 3. The exterior of the clot may become consolidated, whilst the interior contains fluid and disintegrated blood.

Symptoms.—The symptoms of extravasation are often by no means very clear; being those of compression, associated in the early stages with symptoms indicative of laceration of the brain, and, at a later period, with those of encephalitis. Putting out of consideration, however, these complications, the more special symptoms of compression from extravasated blood may occur in two ways.

In the first variety there are three distinct stages; viz., concussion, a return and some continuance of consciousness, and then coma gradually supervening. The patient is concussed or stunned as usual, after the receipt of a blow on the head; from this he quickly rallies, and then symptoms of compression set in, and gradually increase in intensity. He becomes drowsy and dull, with a slow and laboring pulse, dilated and sluggish pupils, and a tendency to slow respiration; as the compression increases, complete stupor at length comes on, with stertor in breathing, and there is either general paralysis, or hemiplegia of the side opposite to the seat of injury.

When the symptoms run this regular course, it is probable that the extravasation results from injury of one of the meningeal arteries or large venous sinuses; that the extravasation is confined to the membranes of the brain; and that there is no laceration of the substance of this organ. This may be termed the **Meningeal Extravasation**; it most commonly arises from rupture of the middle meningeal artery, which, from its situation in a deep canal in the parietal bone, is peculiarly apt to be torn in injuries of the side of the skull.

More commonly, however, the patient never recovers his consciousness after having been stunned, the symptoms of concussion speedily passing into those of compression. In these cases the paralysis is commonly incomplete, often hemiplegic, and is associated with twitching of the limbs or convulsive movements of the body generally, and much restlessness with incoherent muttering: the pupils are sometimes contracted, sometimes dilated, and occasionally squinting is observed. It is especially when there are convulsions, that the pupils are observed to be in different conditions; and I have most frequently noticed the pupil dilated on the side that is most convulsed. The extravasation is probably connected with and dependent on laceration or disorganization of a portion of the brain, and may consequently be termed the **Cerebral Extravasation**.

Diagnosis.—The diagnosis of these two forms of extravasation from one another is important, as it is in the meningeal only that any operative procedure can be successfully undertaken; and it may usually readily be effected by attention to the symptoms just detailed.

The diagnosis between the compression from *extravasation* and that from *depressed bone* or *inflammatory effusions within the skull*, is easily made. In the case of depressed fracture, the symptoms of compression continue uninterruptedly from the very first, and proper examination of the skull will always lead to the detection of the injured bone. When inflammatory effusions, whether of pus, lymph, or serum, exercise undue pressure upon the brain, the signs of compression are preceded by symptoms of cerebral inflammation, and are accompanied by a good deal of pyrexia, by quick pulse and hot skin; the character of the scalp-wound likewise, and the separation of the pericranium when pus is effused,

enable us to distinguish this condition from that in which the pressure is the result of extravasated blood.

From *apoplexy*, the diagnosis is not always easily made, more particularly when there is no evidence that the head has been injured. I could give numerous instances of this. (The following will suffice. A man was brought to University College Hospital in a state of profound coma, in which condition he had been found lying in the street. There was no evidence of injury about the head, beyond a bruise, which had probably been received when he fell. The case, which was supposed to be one of apoplexy, and treated accordingly, proved fatal in a few hours. On examination after death the skull was found fractured, but not depressed. On the opposite side to the bruise and fracture, a coagulum, weighing nearly four ounces and compressing the brain lay between the dura mater and bone.) In such a case, it is evident that the history can alone afford a clue to its true nature. Even when the head has been injured, it is not always easy. (A man was admitted under my care, comatose. A fortnight previously, he had been struck on the left side of the head behind the ear. He was stunned, bled freely from the left ear, but then recovered tolerably, and went about his avocations as usual until the day before his admission, when he became suddenly comatose. There were stertor, quick pulse, and some heat of head; the right pupil was natural, the left contracted. He was treated antiphlogistically, but died on the third day. On examination, a fracture on the left side of the skull was found, extending into the left internal meatus; on the right side of the head, immediately opposite the fracture and the seat of injury, there was a large coagulum in the cavity of the arachnoid, with some sero-plastic exudation about it.) Here was a meningeal extravasation, the result of *contrecoup*, existing without symptoms for fourteen days, and then proving rather suddenly fatal by inflammation. (A woman, whilst walking with her sister, fell in the street. She was taken up insensible; thought to have a fit; became comatose, hemiplegic in the right side, and died the next day. After death the left parietal bone was found fractured, and a clot that weighed five and a half ounces was found lying over the ruptured middle meningeal artery on the dura mater.) Or the injury may be so slight as barely to attract attention (a lady going into the opera stumbled as she went down some stairs, and struck the side of her head against the wall. She felt giddy and confused, returned home, went to bed, was found comatose the next day. I was sent for, but before I could trephine her she had died. On examination, a four-ounce clot was found on the dura mater, under a ruptured meningeal artery, but without fracture. I have seen the same in a boy, who, running down stairs to his dinner, struck his head against the opposite wall; he ate his dinner, vomited, became drowsy, and died. A large clot was found in the dura mater at the part struck.) In neither of these cases was there any external bruise or other sign of injury.

The insensibility of *drunkenness* may usually be distinguished from the coma resulting from injuries of the head, by the absence of local mischief, by the smell of the breath, and by the face of the drunkard being flushed and turgid, and not pale as in a person who is suffering from the effects of a severe injury. When a drunken person has met with an injury of the head and is insensible, he should always be carefully watched, however slight the injury may appear to be, until sufficient time has elapsed for him to recover from his drunken fit; as it is impossible to say whether the stupor be the result of intoxication, or of mischief within the skull; and I have known cases to be sent away from

hospitals as drunk, when in reality the stupor was occasioned by depressed bone.

In the stupor from *poisoning by opium*, the condition of the pupils, which are contracted to the size of a pin's point, instead of being widely dilated as in coma from cerebral compression, will enable the Surgeon to make the diagnosis.

The **Treatment** of extravasation of blood may be conducted on two principles, either by means of general and local antiphlogistic measures, having for their object the arrest of further hæmorrhage, the promotion of absorption, and the subdual of inflammatory action; or else by the application of the trephine, with the view of allowing the escape of the effused blood.

The line of treatment to be adopted should, I think, have reference to the character of the symptoms. When these indicate *cerebral* extravasation, trephining can be of little service, and we must be content with general anti-inflammatory measures; but when the extravasation seems to be *meningeal*, then an attempt may be successfully made to evacuate the extravasated blood.

Although **Trephining** in cases of extravasation was formerly much in vogue, it is seldom had recourse to by modern Surgeons, and is only proper in the meningeal form of extravasation. It is very true that, if it can be ascertained without doubt that the extravasation is not only meningeal, but that it is so situated that the blood may be removed through the trephine-aperture, and if there be no other serious injury to the brain or skull, the operation should at once be performed. And doubtless cases occasionally happen in which, from the situation of the blow, and perhaps the presence of a capillary fissure over the course of the middle meningeal artery, the gradual supervention of signs of compression after an interval of consciousness, and the occurrence of hemiplegia on the side opposite to that which has been struck, the Surgeon is warranted in making an aperture in the skull at the seat of injury, in order to remove the blood that has been poured out, and to arrest its further effusion. But the instances in which this assemblage of symptoms exist, with sufficient precision to justify an operation, are exceedingly rare. Out of many hundred cases of serious and fatal injury of the head that have been admitted into University College Hospital during the last twenty-eight years, in four cases only, I believe, has it been found advisable to have recourse to trephining for the removal of extravasated blood. In three of these cases death speedily ensued, the coma being unrelieved by the operation. In the fourth case, recovery took place. The successful case to which I refer was that of a man admitted comatose, three days after receiving an injury of the head by a fall from a cab. There was no serious symptoms for some hours after the accident; but then stupor gradually came on, amounting at last to complete coma. On examination, a bruise of the scalp was found on the left temple: through this I made an incision, and, finding a starred fracture over the sinus of the middle meningeal artery, trephined the bone, when a large coagulum was found lying upon the dura mater, and, on removing this, fluid arterial blood freely welled up. The coma was relieved, and the patient made a good recovery. In fact, in all cases of this kind where there has been a fall or blow on the head, even though there may be no external marks of violence, the Surgeon should cut down on the skull, and examine it for fracture—to trephine if necessary. If there be no injury to the bone, no evil can result in such a case from the simple incision in the scalp. If there be fracture, the incision is the only means

of diagnosis, and the first step towards saving life. But it must be borne in mind that, however clear the signs, extravasation may not be met with where the Surgeon expects to find it. In these circumstances, it is better not to prosecute the search by making fresh trephine-apertures. In no case would a prudent Surgeon trephine over the course of the middle meningeal artery in the absence of local symptoms, on the chance of finding the blood there, as has been recommended by some of the older Surgeons. The most serious objection to the application of the trephine in cases of extravasation does not, however, consist so much in the difficulty of determining that blood has been effused within the skull, or that the extravasation is of the meningeal form, as in the difficulty of diagnosing that it is so seated between the dura mater and the skull as to admit of removal; not being effused at the base, nor so widely coagulated over the surface of the brain as to be unable to escape through the aperture that may be made. The likelihood of the co-existence of fracture of the base of the skull and of laceration of the brain, giving rise to the cerebral form of extravasation, must also be taken into account. For these various reasons, Surgeons now very wisely content themselves, in the great majority of cases of extravasation, with the employment of antiphlogistic treatment, on the principles already stated. The head should be shaved, the ice-bladder applied, the patient bled, purged, and kept at perfect rest. If, however, the signs be urgent, and pretty clearly indicate the meningeal form of extravasation, and more especially if there be hemiplegia on the side opposite to that on which the blow has been received, with an injury in the course of the middle meningeal artery, the trephine may be applied at the seat of injury and the blood removed. The middle meningeal artery will be found at a point one inch and a half behind the external angular process of the frontal bone and from one inch and a half to two inches above the zygoma. A T-shaped incision should be made with one part parallel to the zygoma and one at right angles to it, the centre of the vertical incision being opposite the point above mentioned. The fibres of the temporal muscles are cut through, the bone cleaned, and the crown of a large trephine applied, with the pin of the instrument over the spot where the vessel is supposed to lie. Under this the extravasated blood and the artery will be found.

OPERATION OF TREPHINING.

Before concluding the subject of injuries of the head, it is necessary to say a few words on the operation of **Trephining**, which, though far less commonly employed in the present day than heretofore, is one of sufficient frequency, as well as of great importance from the serious nature of the cases that require it.

The operation of trephining may be required for one of the six following conditions, viz.:—

1. Simple depressed fracture of the cranium with symptoms of compression.
2. Compound depressed fracture of the cranium, with or without symptoms of compression.
3. Punctured or incised fracture of the cranium.
4. Extravasation of blood between the cranium and dura mater from rupture of the middle meningeal artery.
5. Intracranial abscess.
6. For the removal of a bullet lodged within the cranium.

The trephine may thus be applied to the skull for the fulfilment of one

of two principles; either with the view of preventing inflammation, and its consequences, or for the purpose of removing some cause of compression. The only case in which *preventive* trephining is practised by modern Surgeons, is that of the punctured or starred fracture of the skull, without stupor; in all other instances in which it is called for, the object of its application is the *removal* of a cause of compression or of irritation of the brain, such as a depressed portion of bone, foreign bodies either fixed in the skull or lying close under it, or pus or blood extravasated within the cranial cavity.

The trephine should have a well-tempered crown, serrated half-way up its exterior; the teeth should be short and broad, and not too fine; the centre-pin must not project more than about one-sixteenth of an inch, and care must be taken that the screw which fixes it is in good working order. The other instruments required are a Hey's saw, an elevator that will not readily snap, and a pair of strong dissecting-forceps.

The operation itself should be conducted in the following way. The head having been shaved, and the portion of the skull to which the trephine is to be applied having been freely exposed by means of a crucial or T-shaped incision, or by the enlargement of any wound that may exist, the trephine, with the centre-pin protruded and well-screwed down, is to be firmly applied until its teeth touch the skull (Fig 252); it is then worked with rather a sharp, light, and quick movement, the pressure being exercised as the hand is carried from left to right. The centre-

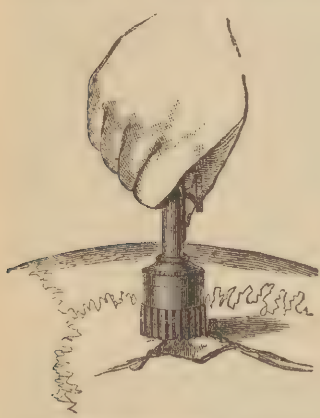


Fig. 252.—Application of Trephine.

Fig. 253.—Trephine-cut at edge of Fracture.

pin must be withdrawn as soon as a good groove is formed by the crown, lest it perforate the skull first and injure the dura mater. In this way the outer table of the skull is quickly divided, and the diploë cut into (Fig. 253); the detritus which now rises by the crown of the trephine is soft and bloody, instead of being dry, as it is whilst the outer table is being sawn. As the instrument approaches the dura mater, the sawing must be conducted more warily, and must every now and then be interrupted, in order that the Surgeon may examine with the flat end of a probe, or with a quill, the depth that has been obtained, care being taken that this is uniform throughout the circle. The Surgeon now makes each turn very lightly, and now and then tries with a slight to-and-fro movement whether the circle of bone is loose. So soon as it is, he withdraws it in the crown of the trephine, or raises it out by means of the

elevator. In this operation the dura mater must not be wounded; if it be injured, fatal consequences will probably ensue. The objects for which the trephining has been had recourse to must now be carried out, depressed bone being elevated or removed, and pus or blood evacuated. The scalp should then be laid down again, a few sutures and a piece of water-dressing being applied.

There are certain parts of the skull—over the venous sinuses, for instance, and near the base—to which no prudent Surgeon would apply the instrument. So, also, if it were ever thought necessary to trephine at the frontal sinuses, the outer table must first be removed with a large crown, and the inner table sawn out with a smaller one.

After the operation, careful attention must be paid to the antiphlogistic measures of a preventive and curative kind, the great direct danger to be apprehended being inflammation of the brain and its membranes. In some cases, also, there is reason to believe that suppurative phlebitis of the sinuses and veins of the diploë has been the cause of death.

The operation of the trephining is by no means a favorable one in its results. Of 45 cases reported by Lente, as occurring at the New York Hospital (in which, however, there is no distinction made between the application of the trephine proper and of various instruments, such as the elevator, Hey's saw, &c., belonging to a trephining case), only 11, or about one-fourth, recovered. Of 17 cases in which the trephine proper was used at the University College Hospital, by Cooper, Liston, and myself, 6 patients recovered: 1 other died of injury of the spine unconnected with the operation, and the remaining 10 died from various causes. In the late American war, the results have been more satisfactory than the previous experience of Army Surgeons would have led us to hope. Of 107 cases of trephining, 47 recovered: and of 114 cases where fragments of bone were removed by the forceps and elevator, without the use of the trephine, 53 recovered. The Parisian Surgeons have not been very successful. Nélaton says that all the cases of injury of the head, 16 in number, in which the trephine had been used in the Parisian hospitals during fifteen years, terminated fatally.

But, although cases in which the trephine is used thus commonly terminate fatally, it would not be right to attribute the unfavorable result to the operation itself. In the majority of cases, death results rather from the injury sustained by the brain, from the pressure of extravasated blood at the base, or from encephalitis induced by the cerebral lesion. And, as the cases to which modern Surgeons now restrict the use of the trephine would necessarily prove fatal if left to themselves, it is but right to give the patient the slender chance of one to three of escaping with life.

CHAPTER XXV.

INJURIES OF THE SPINE.

Injuries of the spine, like those of the head, derive their importance from the degree to which the inclosed nervous structures are liable to be implicated.

The spinal cord is subject to *Concussion*, *Compression*, and *Inflammation*, as the result of external violence; and any of these conditions

may occur without injury to the osseous and ligamentous structures investing it, although, in the majority of cases, they are directly occasioned by fracture or dislocation of the vertebræ. The cord may also be *partially or completely divided* by cutting instruments, gun-shot wounds, or broken vertebræ.

CONCUSSION OF THE SPINAL CORD[1]

It is by no means easy to give a clear and comprehensive definition of the term **Concussion of the Spinal Cord**. This phrase is generally adopted by Surgeons to indicate a certain state of the cord occasioned by external violence; a state that is independent of, and usually, but not necessarily, uncomplicated with, any obvious lesion of the vertebral column, such as fracture or dislocation; a condition that is supposed to depend upon a shake or jar received by the cord, by which its intimate organic structure is more or less deranged, and by which its functions are greatly disturbed, and in which various symptoms indicative of loss or modification of innervation are immediately or remotely induced.

It appears that Surgeons and writers on diseases of the nervous system have included four distinct pathological conditions under this one term, *concussion of the spinal cord;* viz., 1. A jar or shake of the cord, disordering, to a greater or less degree, its functions, without any lesion perceptible to the unaided eye; 2. Compression of the cord from extravasated blood; 3. Compression of the cord from inflammatory exudations within the spinal cord, whether of serum, lymph, or pus; and, 4. Chronic alterations of the structure of the cord itself, as the result of impairment of nutrition consequent on the occurrence of one or other of the preceding pathological states, but chiefly of the third. These various conditions differ remarkably from one another in symptoms and effects, and have only this in common, that they are not dependent upon an obvious external injury of the spine itself; in which respect they differ from the laceration or compression of the cord by the fracture with displacement or the dislocation of a vertebra.

Symptoms indicative of concussion of the spinal cord have of late years frequently occurred, in consequence of injuries sustained in railway collisions, and have been very forcibly brought under the observation of Surgeons in consequence of their having been the fertile sources of litigation; actions for damages for injuries alleged to have been sustained in railway collisions having become of such frequent occurrence as now to constitute a very important part of medico-legal inquiry. The symptoms that arise from these accidents have been very variously interpreted. Some practitioners have ignored them entirely, believing that they exist only in the imagination of the patient; or, while admitting their existence, have attributed them to other conditions of the nervous system which could not have arisen from the alleged accident. And when their connection with, and dependence upon, an injury have been incontestably proved, no little discrepancy of opinion has arisen as to the ultimate result of the case, the permanence of the symptoms, and the curability of the patient. I cannot too strongly urge the fact that there is in reality nothing special in the symptoms of concussion of the spine produced by railway collisions, except in the severity of the accident by which the concussion is occasioned, and that it is conse-

[1] I would refer the reader to my work on "Concussion of the Spine, Nervous Shock, and other Obscure Injuries of the Nervous System," London, 1875, for a more complete exposition of this subject than can be given here.

quently a mistake to look on a certain class of symptoms as special and peculiar to railway accidents. Injuries received on railways may differ in their severity, but do not differ in their nature, from injuries received in the other accidents of civil life. There is no more real difference between that concussion of the spine which results from a railway collision and that which is the consequence of a fall from a horse or a scaffold, than there is between a compound and comminuted fracture of the leg occasioned by the grinding of a railway carriage over the limb and that resulting from the passage of the wheel of a cart across it. In either case, the injury arising from the railway accident will be essentially of the same nature as that which is otherwise occasioned; but it will probably be infinitely more severe and destructive in its effects, owing to the greater degree of violence that occasions it.

Concussions of the spinal cord may be produced either by *direct violence*, as by severe blows or falls on the back, giving rise to local pain and signs of contusion, or by slight blows: or by *indirect violence*, as when a person meets with a general fall, jar, or concussion of the body, without any evidence of a blow having been inflicted on the spine itself; or by *twists and sprains*, or wrenches, of the vertebral column.

Concussion from Direct Violence.—Concussion or commotion of the spinal cord, as a consequence of severe and direct blows upon the back, has long been recognised and described by those writers who have occupied themselves with the effects of injuries to this part of the body.

The **Primary Symptoms** of concussion of the cord immediately and directly produced by a severe blow upon the spine will necessarily vary in severity and extent according to the situation of the injury, the force with which it has been inflicted, and the amount of organic lesion that the delicate structure of the cord has sustained from the shock or jar to which it has been subjected. A severe blow upon the **Upper Cervical Region** may produce instantaneous death. A less severe blow may produce paralysis of one or of all the limbs, with every possible modification of combined or disassociated loss of motor power and of sensation, of hyperæsthesia and of anæsthesia. Or it may give rise to various phenomena, dependent on irritation of the large nerves that take their origin from the medulla oblongata. Thus, when the *vagus nerve* is affected, a sense of suffocation, with irregular action of the heart, may be experienced, or severe vomiting may be established, and may continue for months. Sometimes the *spinal accessory nerve* is affected, and the trapezius or the sterno-mastoid muscle thrown into a more or less permanent spasmodic state. From irritation of the *phrenic nerve*, hiccup and a peculiar sense of constriction round the body, as if the patient were girt by an iron band, may be established.

When the **Lower part of the Cervical Spine** has been struck so as to concuss the cord, I have known paralysis of one or both arms induced, without any paralytic symptoms of the trunk or legs. In these cases the paralysis may go off entirely; or it may disappear in one arm and continue in the other; or one nerve only may continue to be affected—such as the *circumflex*, the *musculo-spiral*, or the *ulnar*. There may be complete paralysis of sensation and of motion in any one of these nerves; or motor power may be lost, whilst sensation is normal; or, more commonly, where the sensibility continues, it is exalted, and we may find loss of motor power with hyperæsthesia. These modifications of innervation may be confined to one nerve, as the musculo-spiral, when there will be loss of motor power in the extensors and supinators of the forearm and hand, with loss of sensation or with hyperæsthesia of the skin

of the hand supplied by the *radial* nerve. In other cases we find motor paralysis of the circumflex or musculo-spiral nerve, and hyperæsthesia of the ulnar. In these respects there is every possible variety.

A severe blow inflicted on the **Dorsal** or the **Lumbar Region** may induce more or less complete paraplegia. In some cases the paralysis of the lower limbs has been complete and instantaneous; and has affected both sensation and motion, with loss of power over the sphincters. In other cases there has only been paralysis of motion, sensation continuing perfect or being in excess. The reverse has been met with, but less frequently and less completely, there being loss of sensation, and impairment, though not complete loss, of power over motion. One leg is frequently more severely affected than the other. Or the two legs may be unequally affected as to sensation and motion; both sensation and motion being impaired, but in varying degrees in the two limbs. There may be complete loss of power over the sphincters both of the bladder and anus, with incontinence or retention of urine and fæces; or the loss of power may be confined to the bladder only. This is especially the case when there is paralysis of motion rather than of sensation in the lower limbs. The state of the urine will vary. If there be no retention, it will continue acid. When there is retention, the urine usually becomes alkaline, but sometimes, even when there is complete retention, it remains strongly acid; and Ollivier noted the very remarkable circumstance in one case of retention, that there was an enormous formation of uric acid, so that the catheter became loaded with it. Priapism does not occur in concussion, while it does so often in cases of laceration or irritation of the cord.

The **Temperature** of the paralysed parts is generally notably lower than that of the healthy parts of the body, and in some cases an absence of normal perspiration has been observed.

The **Secondary Symptoms** of severe concussion of the spine are usually those of the development of inflammation in the meninges and in the cord itself. They consist of *pain* in some part or parts of the spine, greatly increased by pressure and motion, and *rigidity* of the vertebral column, the patient moving it as a whole. The pain is greatly increased by all movements, but especially by those of rotation. It frequently extends as a line down the limbs or as a circle round the body, giving the sensation of a cord tied tightly.

If the case go on to the development of acute inflammatory action in the cord and its membranes, *spasms* of a serious character come on; at first, usually of the nature of trismus; then general spasms of the body and limbs, mostly followed by speedy death from the exhaustion produced by their repetition.

If the inflammation become chronic or subacute, permanent *alterations in the structure of the cord* will ensue, leading to incurable paralytic affections, usually confined to the lower extremities, but sometimes influencing the brain, and associated with great and deep-seated derangement of the general health.

White softening of the cord, unassociated with signs of inflammation of it or its membranes, may be the result of a blow on the back. In this condition paralysis of sensation or motion, often accompanied by peculiar rigidity of the muscles, may come on, and ultimately advance to general paralysis.

Causes of Death.—Concussion of the spinal cord from a severe and direct blow upon the back may prove fatal at very different periods, depending partly on the situation of the blow, and in a great measure on the lesions to which it has given rise. Sudden and fatal paralysis

has often occurred, without leaving after death any lesion of the cord that could be assigned as the cause of death. Abercrombie says, "Concussion of the cord may be speedily fatal without producing any morbid appearance that can be detected on dissection." And he refers to a case related by Boyer, and four recorded by Frank, in confirmation of this remark.

In other cases the fatal result may be occasioned by direct and demonstrable injury of the spine or cord. There appear to be four forms of lesion that will lead to death in spinal concussion from direct severe violence.

1. Hæmorrhage within the spinal canal:—*a.* Between the vertebræ and the dura mater; *b.* Between the membranes and the cord; *c.* In both situations. In these respects, intravertebral extravasations resemble closely those which occur as the result of injury within the cranium.

2. Laceration of the pia mater and hernia of the cord.

3. Extravasation into the substance of the cord.

4. Inflammation, and, perhaps, suppuration of the meninges, with softening and disintegration of the substance of the cord. This disintegration is, doubtless, of an acute and probably inflammatory character.

Concussion of the spinal cord from a direct and severe injury of the back may also terminate in complete recovery after a longer or shorter time, or in incomplete recovery. The probability of the termination in recovery does not depend so much on the actual severity of the immediate symptoms that may have been occasioned by the accident, as on their persistence. If they continue beyond a certain time, changes will take place in the cord and its membranes which are incompatible with the proper exercise of its functions.

Injuries of the Vertebral Column in Concussion.—In concussion of the spinal cord, there is, in addition to the lesion of the cord, serious injury inflicted on the ligamentous and bony structures of the vertebral column. This injury, however, must be considered as an accidental complication, as it does not necessarily occasion, or even aggravate, the mischief done to the medulla. Thus the ligaments may be torn through so as to allow partial separation of contiguous vertebræ; or, a vertebræ may be fractured, but without any displacement of the broken fragments, or other sign by which it is possible during life to determine the exact amount of injury inflicted on the parts external to the cord. In this respect injuries of the spine closely resemble those of the head; their chief importance depending on the amount of injury inflicted upon the contained parts. In the spine, as in the head, it will sometimes be found after death from what appears to be, and in reality is, simple injury of the nervous centres, that the vertebral column in the one case, and the skull in the other, has suffered an amount of injury unsuspected during life; and which, though it may not in any way have determined the fatality of the results, yet affords conclusive evidence of the violence to which the parts have been subjected, and the intensity of the disorganizing shock that they have suffered.

There is, however, a very essential difference between the spine and the head. A simple fracture of the cranium may be of no moment, except so far as the violence that has occasioned it may have influenced the brain. In the spine, the case is not parallel; for, as the vertebral column is the centre of support to the body, its function in this respect will be lost when it is broken; even though the spinal cord may not have

been injured by the edges of the fractured vertebræ, but simply violently and fatally concussed by the same force that broke the spine.

Boyer noticed the very interesting practical fact, that when the interspinous ligaments were ruptured in consequence of forcible flexion of the spine forwards, no fatal consequences usually ensued, the integrity of the parts being restored by rest; but that, when the ligamenta subflava were torn through, and the arches separated, paraplegia and death followed. This he attributed to stretching of the spinal cord. Sir C. Bell, however, with great acuteness, has pointed out the error of this explanation, and states that "it is the progress of the inflammation to the spinal marrow, and not the pressure or the extension of it, which makes these cases of subluxation and breach of the tube fatal." There can be no doubt that this explanation is the correct one; and that, when once the spinal canal is forcibly torn open, fatal inflammation will spread to the meninges and to the medulla itself.

Effects of Slight Blows.—The consideration of the effects that may be produced on the spinal cord by *slight blows*, whether applied to the back or to a distant part of the body, has long arrested the attention of observant practitioners. Abercrombie, writing in 1829, says, that chronic inflammation of the cord and its membranes "may supervene upon very slight injuries of the spine." He says also, "Every injury of the spine should be considered as deserving of minute attention. The more immediate cause of anxiety in such cases is inflammatory action, which may be of an acute or chronic kind; and we have seen that it may advance in a very insidious manner even after injuries that were of so slight a kind that they attracted at the time little or no attention." Nothing can be clearer or more positive than this statement. These remarks of Abercrombie are confirmed by Ollivier, by Bell, and by other writers on such injuries.

Concussion from Indirect Violence.—There is a class of cases of an extremely insidious and protracted character, in which the patient has received no blow or injury upon the head or spine, but the whole system has had a severe shake or shock, in consequence of which disease is developed in the spinal cord, perhaps eventually extending to the membranes of the brain. These cases are more frequent in railway than in other injuries; but they occasionally occur in consequence of ordinary accidents.

One of the most remarkable circumstances connected with injuries of the spinal cord is, the disproportion between the accident and the mischief produced thereby. Not only do most serious, progressive, and persistent symptoms of concussion of the spinal cord often develop themselves after apparently slight injuries, but frequently when there is no sign whatever of external lesion. The shake or jar inflicted on the spine when a person jumping from the height of a few feet comes to the ground suddenly and heavily on his heels or in a sitting posture, has been well known to Surgeons as a not uncommon cause of spinal weakness and debility. It is the same in railway accidents; the shock to which the patient is subjected being often followed by a train of slowly progressive symptoms, indicative of concussion and subsequent irritation and inflammation of the cord and its membranes.

It is worthy of remark, that the symptoms of spinal concussion seldom occur when a serious injury has been inflicted on one of the limbs, unless the spine itself have at the same time been directly and severely struck. A person who by any ordinary accident has one of his limbs fractured or dislocated, necessarily sustains a very severe shock; but it is extremely

rare to find that the spinal cord or the brain has been injuriously influenced. It would appear as if the violence of the shock expends itself in the production of the fracture or the dislocation, and that a jar of the more delicate nervous structures is thus avoided. A familiar illustration of this is afforded in the injury sustained by a watch by falling on the ground. A watchmaker once told me that, if the glass be broken, the works are rarely damaged; if the glass escape unbroken, the jar of the fall will usually be found to have stopped the movement.

How these jars, shakes, shocks, or concussions of the spinal cord directly influence its action, I cannot say with certainty. When a magnet is struck a heavy blow with a hammer, the magnetic force is jarred, shaken, or concussed out of the iron. So, if the spine be severely jarred, shaken, or concussed by a blow or shock of any kind communicated to the body, we find that the nervous force is to a certain extent shaken out of the man, and that he has in some way lost nervous power. What immediate change, if any, has taken place in the nervous structure to occasion that effect, we no more know than what change happens to a magnet when struck.

Secondary Effects.—Whatever may be the nature of the primary change that is produced in the spinal cord by a concussion, the *secondary effects* are clearly inflammatory, and are identical with those phenomena that have been described by Ollivier, Abercrombie, and others, as dependent on chronic meningitis of the cord, and subacute myelitis.

One of the most remarkable phenomena attendant upon this class of cases is, that at the time of the occurrence of the injury the sufferer is usually quite unconscious that any serious accident has happened to him.

The period of the supervention of the more serious, persistent, and positive symptoms of spinal lesion will vary greatly. Most commonly, after the first and immediate effects of the accident have passed off, there is a period of comparative ease, and of remission of the symptoms, during which the patient imagines that he will speedily regain his health and strength This period may last for many weeks, possibly for two or three months. Although there is often this long interval between the time of the occurrence of the accident and the supervention of the more distressing symptoms, it will be found, on close inquiry, *that there has never been an interval of complete restoration to health.* His friends remark, and he feels that "he is not the man he was." He has lost bodily energy, mental capacity, and business aptitude. He looks ill and worn; often becomes irritable and easily fatigued. He still believes that he has sustained no serious or permanent hurt, and so long as he is at rest, he will feel tolerably well; but any attempt at ordinary exertion of body or mind brings back all the feelings or indications of nervous prostration and irritation characteristic of these injuries; and to these will gradually be superadded the more serious symptoms which evidently proceed from a chronic disease of the cord and its membranes. After a lapse of several months—from three to six—the patient will find that he is slowly but steadily becoming worse, and he then, perhaps for the first time, becomes aware of the serious and deep-seated injury that his nervous system has sustained.

The *countenance* is usually pallid, sometimes even livid, and has a peculiarly careworn, expressionless look; the patient generally looking much older than he really is, or than he did before the accident. I have seen, however, instances of flushing of the face.

The *thoughts* are confused. The patient cannot concentrate his ideas so as to carry out a connected line of reasoning; he attempts to read,

but is obliged to lay aside the book or paper after a few minutes' attempt at perusal. All *business aptitude* is lost; partly from impairment of memory, partly from confusion of thought, and inability to concentrate ideas for a sufficient length of time. The *temper* often becomes changed for the worse, the patient being fretful, irritable, and in some way—difficult perhaps to define, but easily appreciated by those around him—altered in character.

The *sleep* is disturbed, restless, and broken. He wakes up in sudden alarm; dreams much; the dreams are distressing and horrible.

The *head* is usually of its natural temperature, but sometimes hot. The patient complains of various uneasy sensations in it; of pain, tension, weight, or throbbing; of giddiness; of a confused or strained feeling in it; and frequently of loud and incessant noises, described as roaring, rushing, ringing, singing, sawing, rumbling, or thundering. These noises vary in intensity at different periods of the day; but, if once they occur, they are never entirely absent, and are a source of great distress.

The *organs of special sense* usually become more or less seriously affected. They become sometimes over-sensitive and irritable, or their functions are impaired or perverted. In many cases we find a combination of all these conditions in the same organ. *Vision* is usually affected in various ways and in very different degrees. In some cases, though rarely, there is double vision and perhaps slight strabismus. In others there is an alteration in the accommodation of the eye, so that the patient has to use glasses, or to change those which he has previously worn. The patient cannot read for more than a few minutes, the letters running into one another. More commonly, muscæ volitantes and spectra, rings, stars, flashes, or sparks—white, colored, or flame-like—are complained of. The eyes often become over-sensitive to light; and this intolerance of light may amount to positive photophobia. It gives rise to a habitually contracted state of the brows, so as to exclude light as much as possible from the eyes. One or both eyes may be thus affected. This intolerance of light may be associated with dimness and imperfection of sight. Vision may be normal in one eye, but impaired seriously in the other. The circulation in the fundus of the eye is visible to some patients. The *hearing* may be variously affected. Not only does the patient commonly complain of the noises in the head and ears that have already been described, but the ears, like the eyes, may be over-sensitive or too dull. One ear is frequently over-sensitive, whilst the other is less acute than it was before the accident. The relative sensibility of the ears may readily be measured by the distance at which the tick of a watch may be heard. Loud and sudden noises are peculiarly distressing to these patients. *Taste* and *smell* are sometimes, but more rarely, perverted.

The *sense of touch* is impaired. The patient cannot pick up a pin, cannot button his dress, cannot feel the difference between different textures, as cloth and velvet. He loses the sense of *weight*, and cannot tell, for instance, whether a sovereign or a shilling is balanced on his finger. *Speech* is rarely affected. The *attitude* is stiff and unbending. The patient holds himself very erect, usually walks straight forwards, as if afraid or unable to turn to either side. The *movements of the head or trunk*, or both, do not possess their natural freedom. There may be pain or difficulty in moving the head in the antero-posterior direction, or in rotating it; or all movements may be attended by so much pain and difficulty that the patient is afraid to attempt them, and hence keeps the head in an attitude of immobility. The movements of the trunk are

often equally restrained, especially in the lumbar region. Flexion forwards, backwards, or sideways, is painful, difficult, and may be impossible; flexion backwards is usually most complained of. If the patient be desired to stoop and pick anything off the ground, he will not be able to do so in the usual way, but bends down on the knee and so reaches the ground. If he be laid horizontally, and told to raise himself into the sitting posture, without the use of his hands, he will be unable to do it.

The *state of the spine* will be found to be the real cause of these symptoms. On examining it by pressure, by percussion, or by the application of the hot sponge, it will be found that it is painful, and that its sensibility is exalted at one, two, or three points. These are usually the upper cervical, the middle dorsum, and the lumbar regions. The exact vertebræ that are affected vary necessarily in different cases; but the exalted sensibility always includes two, and usually three, at each of these points. It is in consequence of the pain that is occasioned by any movement of the trunk in the way of flexion or rotation, that the spine loses its natural suppleness, and moves as a whole, as if cut out of one solid piece, instead of with its usual flexibility.

The *movements of the head upon the upper cervical vertebræ* are variously affected. In some cases, the head moves freely in all directions, without pain or stiffness. In other cases, the greatest agony is induced if the Surgeon take the head between his hands and bend it forwards or rotate it; the articulations between the occipital bone, the atlas, and the axis, being evidently in a state of inflammatory irritation. The pain is usually confined to the vertebral column, and does not extend beyond the transverse processes. But, in some instances, the pain extends widely over the back on both sides, and seems to correspond with the distribution of the posterior branches of the dorsal nerves. In these cases, from the musculo-cutaneous distribution of these nerves, the pain is superficial and cutaneous as well as deeply seated.

The *muscles of the back* are usually unaffected; but in some cases, where the muscular branches of the dorsal nerves are affected, they may become very irritable and spasmodically contracted, so that their outlines are very distinct.

The *gait* of the patient is characteristic. He walks more or less unsteadily, generally uses a stick, or if deprived of that, is apt to lay his hand on any article of furniture that is near to him, for the purpose of steadying himself. He keeps his feet somewhat apart, so as to increase the basis of support, and consequently walks in a straddling manner. As one leg is often weaker than the other, he totters somewhat, and raises one foot but slightly off the ground, so that the heel is apt to touch. He seldom drags the toe; but, as he walks flat-footed as it were on one side, the heel drags. This peculiar straddling, tottering, unsteady gait, with the spine rigid, the head erect, and looking straight forwards, gives the patient the aspect of a man who walks blindfolded. The patient cannot generally stand equally well on either foot. One leg usually gives way immediately under him if he attempt to stand on it. He often cannot raise himself on his toes, or stand on them, without immediately tottering forwards. His power of walking is always very limited; it seldom exceeds half a mile or a mile at the utmost. He cannot ride, even if much in the habit of doing so before the accident. There is usually considerable difficulty in going up and down stairs—more difficulty in going down than up. The patient is obliged to support himself by holding on to the balusters, and often brings both feet together on the same step.

A sensation as of a cord tied around the waist, with occasional spasm of the diaphragm, giving rise to a catch in the breathing, or hiccup, is sometimes met with, and is very distressing when it does occur.

The *nervous power of the limbs* will be found to be variously modified, and will generally be so to very different degrees in the different limbs. Sometimes one limb only is affected; in other cases the arm and leg on one side, or both legs only, or the arm and both legs, or all four limbs, are the seat of uneasy sensations. There is the greatest possible variety in these respects, dependent of course entirely upon the degree and extent of the lesion that has been inflicted upon or induced in the spinal cord. Sensation or motion may only be affected; or both may be affected, either alike or in unequal degrees. Sensation and motion may both be seriously impaired in one limb; or sensation and motion in another. The paralysis is seldom complete. It may become so in the more advanced stages, after several years; but for the first year or two it is almost always partial. It is sometimes incompletely recovered from, especially so far as sensation is concerned.

The *loss of motor power* is especially marked in the legs, and more often in the extensor than in the flexor muscles. The extensor of the great toe is especially apt to suffer. The hand and arm are less frequently the seat of loss of motor power than the leg and foot; but the muscles of the ball of the thumb, or the flexors of the fingers, may be affected. The loss of motor power in the foot and leg is best tested by the application of the galvanic current, so as to compare the irritability of the same muscles of the opposite limbs. The electric test is not under the influence of the patient's will; and a very true estimate can thus be made of the loss of contractility in any given set of muscles. The loss of motor power in the hand is best tested by the force of the patient's grasp. This may be roughly estimated by telling him to squeeze the Surgeon's fingers, first with one hand and then with the other, or more accurately by means of the dynamometer, which shows on the index the precise amount of pressure exercised in grasping. It is in consequence of the diminution of motor power in the legs that those peculiarities of gait which have been above described are met with, and they are most marked when the amount of loss is unequal in the two limbs.

Modification or diminution of sensation in the limbs is one of the most marked phenomena in these cases. In many instances the sensibility is a good deal augmented, especially in the earlier stages. The patient complains of shooting pains down the limbs, like stabs, darts, or electrical shocks. The surface of the skin is sometimes oversensitive in places on the back; or, in various parts of the limbs, hot, burning sensations are experienced After a time these sensations give place to various others, which are very differently described by patients. Tingling, a feeling of "pins and needles," a heavy sensation, as if the limb were asleep, creeping sensations down the back and along the nerves, and formication, are all commonly complained of. These sensations are often confined to one nerve in a limb, as the ulnar or the musculo-spiral. Numbness, more or less complete, may exist independently of, or be associated with, all these various modifications of sensation. It may be confined to a part of a limb, may influence the whole of it, or may extend to several limbs. Its degree and extent are best tested by Brown-Séquard's anæsthesiometer.

Coldness of one of the extremities, dependent upon loss of nervous power and defective nutrition, is often perceptible to the touch, and may be determined by the thermometer; but in many cases the sensation

of coldness is far greater to the patient than it is to the Surgeon's hand, and not unfrequently no appreciable difference in the temperature of two limbs can be determined by the most delicate clinical thermometer, although the patient experiences a very distinct and distressing sense of coldness in one limb.

The condition of the limbs as to *size*, and the *state of their muscles*, will vary greatly. In some cases of complete paraplegia, which has lasted for years, it has been remarked that no diminution whatever has taken place in the size of the limbs. It is evident, therefore, that loss of size in a limb that is more or less completely paralysed is not the simple consequence of the disuse of the muscles; or it would always occur. But it must arise from some modification of innervation, influencing the nutrition of the limb, independently of the loss of its muscular activity. In most cases, however, where the paralytic condition has been of some duration, the limb, on accurate measurement, will be found to be somewhat smaller in circumference than its fellow on the opposite side. Most commonly when a limb dwindles the muscles become soft, and the intermuscular spaces more distinct. Occasionally, in advanced cases, some contraction and rigidity in particular muscles set in. Thus the flexors of the little and ring fingers, the extensors of the great toe, the deltoid or the muscles of the calf, may all become more or less rigid and contracted.

The *body* itself generally loses weight; and a loss of weight, when the patient is rendered inactive by a semi-paralysed state, and takes a fair quantity of good food, which he digests sufficiently well, may usually be taken to be indicative of progressive disease in the nervous system. When the progress of the disease has been arrested, though the patient may be permanently paralysed, a considerable increase of size and weight often takes place. This is a phenomenon of common occurrence in ordinary cases of paralysis from disease of the brain.

The condition of the *genito-urinary* organs is seldom much deranged in the cases under consideration. Retention of urine very rarely occurs. Sometimes irritability of the bladder is a prominent symptom. The urine generally retains its acidity, sometimes markedly, at others but very slightly. As there is no retention, it does not become alkaline, ammoniacal, or otherwise offensive. The sexual desire and power are usually greatly impaired, and often entirely lost; not invariably so, however. I have never heard priapism complained of.

The contractility of the *sphincter ani* has not, in any case which I have observed, been so far impaired as to lead to involuntary escape of flatus or of fæces.

The *pulse* varies in frequency at different periods. In the early stages it is usually slow; in the more advanced it is quick, near to, or above 100. It is always feeble.

The **Progressive Development of the various symptoms** that have just been detailed usually extends over a lengthened period. In the early stages, the chief complaint is a sensation of lassitude, weariness, and inability for mental and physical exertion. Then come the pains, tinglings, and numbness of the limbs; next the fixed pain and rigidity of the spine; then the mental confusion and signs of cerebral disturbance, and the affection of the organs of sense; the loss of motor power, and the peculiarity of gait.

It is by this chain of symptoms, which, though fluctuating in intensity, is yet continuous and unbroken, that the injury sustained, and the illness

subsequently developed, can be linked together in the relation of cause and effect.

Pathological Conditions.—Two distinct forms of chronic and subacute inflammation may affect the contents of the spinal canal, as the results of injury or of disease; viz., Inflammation of the Membranes, and Inflammation of the Cord itself.

In **Spinal Meningitis**, the usual signs of inflammatory action in the form of vascularisation of the membranes are met with. The meningo-rachidian veins are turgid with blood, and the vessels of the pia mater are much injected, sometimes in patches, at other times uniformly. Serous fluid, reddened and clear, or opaque from the admixture of lymph, may be found largely effused in the cavity of the arachnoid. In distinguishing the various pathological appearances presented by fatal cases of chronic spinal meningitis, Ollivier makes the very important remark that spinal meningitis rarely exists without there being at the same time a more or less extensive inflammation of the cerebral meninges; and hence, he says, arises the difficulty of determining with precision the symptoms that are special to inflammation of the membranes of the spinal cord.

When **Myelitis** occurs, the inflammation attacking the substance of the cord itself, the most usual pathological condition met with is softening, with more or less disorganization. This softening of the cord, as a consequence of inflammation, may occupy very varying extents. Sometimes the whole thickness of the cord is affected at one point, sometimes one of the lateral halves in a vertical direction; at other times the disease is most marked in or wholly confined to its anterior or its posterior aspect; or the gray central portion may be more affected than the circumferential part. Again, these changes of structure may be limited to one part only, to the cervical, the dorsal, or the lumbar. It is very rarely indeed that the whole length of the cord is affected. The most common seat of inflammatory softening is the lumbar region; next in order of frequency is the cervical. In very chronic cases of myelitis, the whole of the nervous substance disappears, and nothing but connective tissue is left at the part affected. Ollivier observes that, when myelitis is consecutive to meningitis of the cord, the inflammatory softening may be confined to the white substance.

Though softening is the ordinary change that takes place in a cord that has been the seat of chronic inflammation, sometimes the nervous substance becomes increased in bulk, more solid than natural, and of a dull white color, like boiled white of egg. This induration may co-exist with spinal meningitis, with congestion, and increased vascularisation of the membranes.

It is important to observe that, although spinal meningitis and myelitis are occasionally met with distinct and separate, yet they most frequently co-exist. When existing together, and even arising from the same cause, they may be associated in very varying degrees. In some cases the symptoms of meningitis, in others those of myelitis, are most marked; and, after death, corresponding characteristic appearances are found.

Impairment of Vision from Spinal Injury.[1]—One of the most frequent and most troublesome effects of spinal injury is a certain degree of impairment of vision, which assumes different characters, and comes

[1] For a fuller consideration of the subject of *Impairment of Vision as a Consequence of Injuries of the Nervous System*, I would refer my reader to Lecture 10, "Concussion of the Spine," by the Author. Longmans, 1875.

on at very varying periods after the injury. There is often a considerable interval intervening between the occurrence of the injury and the development of the eye-symptoms; and, if the patient be confined to bed, and be not called upon to use his eyes, it may be long before he discovers that their sight is enfeebled. This is more especially apt to be the case, as the attention of the Surgeon may not be directed to the state of the eyes in the first instance. The first and most frequent symptom that is complained of is a dimness or weakness of the sight, so that the patient cannot define the outlines of small objects, and cannot see in an obscure light. If he attempt to read, he can define the letters often of the smallest print for a few seconds or minutes, but they soon run into one another, become obscured and blurred, and ill-defined. Glasses do not materially, if at all, improve this condition. There is often in the early stages some slight irregularity in the axis of the eyes, scarcely amounting, however, to a squint. This blurring, or indistinctness of vision, is often more marked with respect to near than to distant objects. After a time the patient usually suffers from irritability of the eyes, and cannot bear a strong light, even that of an ordinary window, in the daytime, or unshaded gas or lamplight. In consequence of this irritability of the eyes, the brows become involuntarily contracted, and the patient acquires a peculiar frown so as to exclude light as much as possible. This intolerance of light may amount to perfect photophobia, and is then associated with congestion of the conjunctiva and accompanied by lachrymation.

One or both eyes may be thus affected. Sometimes one eye only is intolerant of light. This intolerance of light is usually accompanied by muscæ volitantes and spectra, rings, stars, spots, flashes, and sparks, or an appearance of white-colored flame. The appearance of a fixed luminous spectrum, a line, circle, or colored bar across the field of vision, is sometimes complained of. There is an undue retention of the image in many cases; and where the patient has looked at any fixed object, such as the sun or the fire, complimentary spectral colors, often of the most beautiful character, of varying degrees of intensity, will develop themselves in succession. The patient is in some cases conscious of the circulation in his own eye, which becomes distinctly visible to him, even in its pulsatory character.

From this description of the symptoms of the impairment of vision that follows spinal injury, it would appear that it is of five distinct kinds, which may, however, be associated: 1. Asthenopia, or simple weakness of sight; 2. Amblyopia, a paresis of the optic nerve or retina; 3. Loss or failure of the power of accommodation; 4. Irritability of the eye and photopsia from hyperæmia or inflammation of the optic nerve and retina, which may lead to, 5. Atrophy of the optic nerve.

The objective phenomena presented by the eye, and the ophthalmoscopic appearances seen in the interior of the globe in these cases, have been carefully studied by Wharton Jones and Allbutt. Jones, in his able work "On Failure of Sight after Railway and other Injuries," states that the eyelids are usually half closed; the eyes sunken and watery; the veins of the eyeball congested. The movements of the pupils are sometimes normal; sometimes more sluggish, sometimes more active than usual. This will necessarily depend upon whether the eye be effected by simple asthenopia, or whether there be some hyperæmic or inflammatory state developed in its interior.

The ophthalmoscopic appearances vary greatly. In some cases, as Wharton Jones observes, the morbid state on which the failure of sight

and other subjective symptoms depend, may be at first confined to some central portion of the optic nervous apparatus, and no ophthalmoscopic evidence of implication of the retina or optic disc may present itself till a more advanced stage of the case. Sooner or later, however, whether as the result of primary changes in the fundus, or more slowly from the effect of a slowly progressive inflammatory affection propagated from the intracranial portion of the nervous apparatus towards its periphery, and thus inducing morbid changes in the optic nerve and its disc, we find that the ophthalmoscope reveals changes in the fundus of the eye. "The disc," says Wharton Jones, "is seen to be whitish and somewhat congested; the retinal veins are large, though the fundus usually presents an anæmic aspect, with perhaps some pigmentous degeneration of the retina round the disc."

One or other of these conditions occurs in the majority of cases of spinal injury. Allbutt says, "It is tolerably certain that disturbance of the optic disc and its neighborhood is seen to follow disturbance of the spine, with sufficient frequency and uniformity to establish the probability of a causal relation between the two events." He goes on to say that in 13 cases of chronic spinal disease following accident, he found 8 cases of sympathetic disorder of the eye. My experience fully accords with that of Allbutt. I find that of 60 cases of obscure spinal injury, without fracture or dislocation, that I have consecutively examined, there was impairment of vision in 42 instances.

Allbutt makes the interesting remark, which will be supported by the experience of all Surgeons, that, in the severer forms of spinal injury, those that prove fatal in a few weeks, evidences of eye-disease are not met with. Of 17 such cases he found no evidence of eye-disease in any one instance. This observation affords a most complete answer to an objection that has often been urged, that as sympathetic affection of the eye is rarely met with in severe injuries of the spine, such as fractures and displacement of the vertebræ with traumatic lesion of the cord, its occurrence in the less immediately severe and more obscure forms of injury can scarcely be looked upon as the direct result of the spinal mischief. It would appear, however, from the observations of Allbutt, which I can entirely confirm, that it is in these very cases that it is met with.

That a certain portion of the spinal cord exercises a direct influence on the eyes, has been incontestably established by the experiments of modern physiologists. Budge and Waller, in 1851, demonstrated that the filaments of the sympathetic that supply the eye take their origin from that part of the spinal cord which is contiguous to the origin of the first pair of dorsal nerves; and that the portion of the spinal axis which extends from the fifth cervical to the sixth dorsal vertebra, and, according to Brown-Séquard, as far as the twelfth dorsal, possesses a distinct influence on the organs of vision. Hence by these physiologists it has been termed the "cilio-spinal," and by Claude Bernard the "oculo-spinal" axis. It has been determined as the result of numerous experiments, that the partial division of this cilio-spinal axis exercises various disturbing influences on the size of the pupils, on the vascularisation of the conjunctiva, and probably of the deeper ocular tissues, and on the state of the blood-vessels of the ear, exactly similar to those that are occasioned by the section of the cervical sympathetic The conclusion that must necessarily be deduced from these observations is, that this portion of the spinal cord—the *oculo-spinal axis*—includes within itself both vaso-motor and oculo-pupillary filaments which are connected with the cervical portion of the sympathetic.

Claude Bernard has pointed out clearly the fact that the vaso-motor and the oculo-pupillary nerves possess different reflex actions. By dividing the first two dorso-spinal roots, he finds that the oculo-pupillar phenomena are produced without occasioning the vaso-motor effects of vascular injection and increase of temperature; whereas, by dividing the ascending sympathetic filament between the second and third ribs, the vaso-motor phenomena are developed in the head without any influence being excited on the eye through the medium of the oculo-pupillary filaments. He sums up his observations as follows. "The vaso-motor and the oculo-pupillary nerves do not act in the same way. Thus a slight irritation of the auricular nerve only occasions vascularisation on the corresponding side; whilst the same irritation produces reflex movements in both eyes at the same time. The reflex vascular actions do not appear to be capable of being produced on the opposite side to that which is irritated (d'une manière croisée); and, besides this, they are limited and do not extend beyond a certain determined line of circumscription. All this is in striking contrast with the oculo-pupillar actions, which are on the contrary general and crossed."

Clinical observations support the result of physiological experiment as to the connection that subsists between the oculo-spinal axis of the cord and the integrity of vision. The records of surgery contain numerous illustrations of the injurious influence on the sight of blows inflicted on the lower cervical and upper dorsal spine. Allbutt remarks, that those injuries and concussions of the spine that occur high up are more injurious to vision than such as are inflicted on the lower portion of the vertebral column.

To what is this impairment of vision due? Allbutt, who has studied the subject with much care, gives his opinion, in which I fully coincide, so clearly, that I cannot do better than to quote his own words. "In default of a series of autopsies, we seem to be led towards the conjecture that hyperæmia of the back of the eye, following injury to the spine, is probably dependent upon a greater or less extension of the meningeal irritation up to the base of the brain. Now, have we any reason to suppose that spinal meningitis does creep up into the encephalon? We have: for, setting aside the curious head-symptoms such patients often present, here the actual demonstration of autopsy comes to aid us. It is tolerably well known to careful pathologists that encephalic meningitis is a very common accompaniment of spinal meningitis. It is scarcely needful to point out, if this explanation of an ascending meningitis be the correct one, it accords with my observation stated above, that, in general, the higher the injury to the spine, the sooner the affection of the eye."

Diagnosis.—There are three morbid states, with one or other of which the symptoms of spinal concussion, which have been just described, have sometimes been confounded, and from which it is necessary to diagnose it. These are, 1. The Secondary Consequences of Cerebral Concussion; 2. Rheumatism; and 3. Hysteria.

1. From the **secondary effects of cerebral concussion** it is not difficult to diagnose the consequences of concussion of the spinal cord, in those cases in which the mischief is limited to the vertebral column. The tenderness and rigidity of the spine, the pain on pressing upon or on moving it in any direction, and the absence of any distinct lesion about the head, will sufficiently mark the precise situation of the injury.

The two conditions of cerebral and spinal concussion often co-exist primarily. The shock that jars injuriously one portion of the nervous system, very commonly produces a corresponding effect on the whole of

it, on the brain as well on the cord; and the secondary inflammations of the spine, which follow the concussion, even when that is primarily limited to the cerebral column and its contents, have a tendency to extend along the continuous fibrous and serous membranes to the interior of the cranium, and thus to give rise to symptoms of cerebral irritation.

2. From **rheumatism** the diagnosis may not always be ea·y, especially in the earlier stages of the disease, when the concussion of the spine and the consecutive meningitis have developed pain along the course of the nerves, and increased cutaneous sensibility at points. By attention, however, to the history of the case, the gradually progressive character of the symptoms of spinal concussion, the absence of all fixed pain except at one or more points in the back, the cerebral complications, the gradual occurrence of loss of sensibility, of tinglings and formications, the slow supervention of impairment or loss of motor power in certain sets of muscles (symptoms that do not occur in rheumatism), the diagnosis will be rendered comparatively easy; the more so, when we observe that in spinal concussion there is never any concomitant articular inflammation, and that, although the urine may continue acid, it does not usually show a superabundance of lithates.

3. **Hysteria** is the disease for which I have more frequently seen concussion of the spine, followed by meningo-myelitis, mistaken; and it has always appeared extraordinary to me that so great an error of diagnosis could easily be made. Hysteria, whether in its emotional or its local form, is a disease of women rather than of men, of the young rather than of the middle aged and old, of people of an excitable, imaginative, or emotional disposition rather than of hard headed, active, practical men of business. It is a disease that runs no definite or progressive course, that assumes no permanence of action, that is ever varying in the intensity, in the degree, and in the nature of its symptoms; that is marked by excessive and violent outbreaks of an emotional character, or by severe exacerbations of its local symptoms, but that is equally characterised by long-continued and complete intermissions of its various phenomena. This in no way resembles what we see in concussion of the spinal cord, or in the consecutive meningo-myelitis; and it seems to me quite unreasonable to call a case one of hysteria in which a man active in mind, accustomed to self control, devoted to business, suddenly, and for the first time in his life, after the infliction of a severe shock, finds himself affected by a train of symptoms indicative of serious and deep seated injury to the nervous system. In reality, there can be but little difficulty in establishing the diagnosis between chronic meningo-myelitis and hysteria. The persistence of the symptoms, their slow development, their progressive increase in severity, notwithstanding occasional fluctuations and intermissions in intensity, the invariable presence of more or less paralysis of sensation, or of motion, or both, will easily enable the Surgeon to judge of the true nature of the case. That mental emotion is occasionally manifested by an unfortunate individual who has been seriously injured by an accident which tends to shake his whole nervous system, can scarcely be matter of surprise; but the term "hysteria," elastic as it is, cannot, it appears to me, be strained so far as to include this condition; and even if it be considered applicable to the patient's mental state it can in no way be looked upon as the cause of those bodily sufferings and di-abilities which constitute the most important and serious part of the disease.

Prognosis.—The prognosis of concussion of the spinal cord and that of the consecutive meningo-myelitis is a question of extreme interest in a medico-legal point of view, and is often involved in much difficulty.

The prognosis requires to be made with regard, first to the life, and secondly to the health of the patient. So far as life is concerned, it is only in cases of severe and direct blows upon the spine, in which intra-spinal hæmorrhage to a considerable extent has occurred, or the cord or its membranes have been ruptured, that a speedily fatal termination may be feared.

In some of the cases of concussion of the spine, followed by chronic inflammation of the membranes and of the cord itself, death may supervene after several, perhaps three or four, years of an increasingly progressive breaking down of the general health, and the slow extension of the paralytic symptoms. I have heard of several instances in which concussion of the spine has thus proved fatal some years after the occurrence of the accident.

I have never known a patient recover who has been attacked by convulsions, progressive paralysis developing itself, and the case ultimately proving fatal. Gore, of Bath, informs me that he is acquainted with two cases which proved fatal at long periods of time after the accident, in both of which this symptom was present. Concussion of the spine may prove fatal: first, at an early period by the severity of the direct injury; secondly, at a more remote date by the occurrence of inflammation of the cord and its membranes; and thirdly, after a lapse of several years, by the slow and progressive development of structural changes in the cord and its membranes

If death do not occur, is recovery certain? Is there no intermediate state between a fatal result, proximate or remote, and absolute and complete recovery?

In considering the question of recovery after concussion of the spine, we have to look to two points: first, the recovery from the primary and direct effects of the injury; and, secondly, the recovery from the secondary and remote consequences. There can be no doubt that recovery, entire and complete, may occur in a case of concussion of the spine, when the symptoms have not gone beyond the primary stage, when no inflammatory action of the cord or its membranes has been developed, and more particularly when the patient is young and healthy. This last condition indeed is most important. A healthy young man is not only less likely to suffer from a severe shock to the system from a fall or railway injury than one more advanced in life; but, if he do suffer, his chance of ultimate recovery will be greater, provided always that no secondary and organic lesions have developed themselves. I believe that such recovery is more likely to ensue if the primary and direct symptoms have been severe, and have at or almost immediately after the occurrence of the accident attained to their full intensity. In these cases, under proper treatment the severity of the symptoms gradually subsides, and, week by week, the patient feels himself stronger and better, until, usually in from three to six months at the utmost, all traces of the injury have disappeared.

Incomplete or partial recovery is not infrequent in cases of severe and direct injury of the spine. The patient slowly recovers up to a certain point and then remains stationary, with some impairment of innervation in the shape of partial paralysis of sensation or of motion, or both, usually in the lower limbs. The intellectual faculties or the organs of sense are more or less disturbed, weakened, or irritated, the constitution is shattered, and the patient presents a prematurely worn and aged look. In such cases structural lesion of some kind, in the membranes, if not in the cord, has taken place, which necessarily must prevent complete recovery.

When, therefore, we find a patient who, after the receipt of a severe injury of the spine, by which the cord has been concussed, presents the primary and immediate symptoms of that condition, we may entertain a favorable opinion of his future condition, provided there be a progressive amelioration of his symptoms, and no evidence of the development of any inflammation, acute or chronic, of the membranes of the cord. But our opinion as to his ultimate recovery must necessarily be very unfavorable if the progress of amendment cease after some weeks or months, leaving a state of impaired innervation; the more so if, subsequently to the primary and immediate effect of the injury, symptoms of meningo-myelitis have declared themselves. In such circumstances partial restoration to health may be looked for, but complete recovery is scarcely possible.

When a person has received a concussion of the spinal cord from a jar or shake of the body, without any direct blow on the back, or perhaps on any other part of the body, and the symptoms have progressively developed themselves, the prognosis will always be very unfavorable; for this reason, that, as the injury is not sufficient of itself to produce a direct and immediate lesion of the cord, any symptoms that subsequently appear must be the result of structural changes in it consequent on its inflammation; and these secondary structural changes, being incurable, must to a greater or less degree, but permanently, injuriously influence its action. For the same reason, the occurrence of a lengthened interval, a period of several weeks for instance, between the infliction of the injury and the development of the spinal symptoms, is peculiarly unfavorable. In forming an opinion as to the patient's probable future state, it is of far less importance to look to the immediate or early severity of the symptoms than to their progressive and insidious development.

The time that the symptoms have lasted is necessarily a most important matter for consideration. When they have been of but short duration, they may possibly be dependent on conditions that are completely, and perhaps easily, removable by proper treatment; for instance, on extravasation of blood, or on acute serous inflammatory effusion. But when the symptoms, however slight they may be, have continued even without progressive increase, but have merely remained stationary for a lengthened period of many months, they will undoubtedly be found to be dependent on those secondary structural changes that follow inflammatory action. I have never known a patient to recover entirely, so as to be in the same state of health that he enjoyed before the accident, in whom the symptoms dependent on chronic inflammation of the cord and its membranes, and on their consecutive structural lesions, had existed for twelve months. And though as Ollivier has observed, such a patient may live for fifteen or twenty years in a broken state of health, the probability is that he will die within three or four. There is no structure of the body in which an organic lesion is recovered from with so much difficulty and with so great a tendency to resulting impairment of function, as the spinal cord and brain. And, with the exception probably of the eye, there is no part of the body in which a slight permanent change of structure produces such serious disturbance of function as in the spinal cord.

Treatment.—The general principles of treatment of concussion of the spinal cord are the same, from whatever cause the injury may have arisen.

In the **Early Stages of a case of Concussion of the Spine**, the first thing to be done is undoubtedly to give the injured part complete and absolute *rest*. The importance of rest cannot be over-estimated.

Without it, no other treatment is of the slightest avail; and it would be as irrational to attempt to treat an injured brain or a sprained ankle without rest, as to try to benefit a patient suffering from a severe concussion or wrench of the spine unless he be kept quiet. It is the more important to insist upon absolute and entire rest, for the reason, that not unfrequently patients feel for a time benefited by movement; and hence changes of air and scene are thought to be permanently beneficial. But nothing can be more erroneous than this idea, for the patient will invariably be found to fall back into a worse state than had previously existed. In more advanced stages of the disease, when chronic meningitis has set in, the patient suffers so severely from any, even the very slightest movement of the body, that he instinctively preserves that rest which is needed.

In order to secure rest efficiently, the patient should be made to lie on a prone couch. In the prone position, the spine is the highest part of the body; thus passive venous congestion and determination of blood, which are favored when the patient lies on the back, are entirely prevented. Again, the absence of pressure upon his back is a great comfort when it is unduly sensitive and tender, and is a source of additional safety to the patient, if he be paraplegic, by lessening the liability to the formation of bed-sores. Lastly, the prone position presents this advantage over the supine, that it allows the ready application of local treatment to the spine. In some instances complete and absolute rest may be secured to the injured spine by the application of a gutta-percha case to the back, embracing the shoulders, nape, and back of the head; or by letting the patient wear a stiff collar so as to give support to the neck.

But, if rest is needed to the spine, it is equally so to the brain. In cases of concussion of the spine, the membranes of the brain become liable to the extension of inflammatory action to them. The irritability of the senses of sight and hearing, that is very marked in many of these cases, with perhaps heat of head or flushings of the face, gives the best evidence of this morbid action. For the subdual of this state of increased cerebral excitement and irritability, it is absolutely necessary that the mind should be kept as much as possible at rest. The patient, feeling himself unequal to the fatigue of business, becomes conscious of the necessity of relinquishing it, though not perhaps without great reluctance, and until after many ineffectual efforts to attend to it. There are two remedies which may be employed with much advantage in the earlier stages of spinal concussion, with the view of soothing the irritation of the nervous system. One is chloral-hydrate, to procure sleep; the other, bromide of potassium, to allay irritability.

During the early period of concussion of the spine, much advantage will usually be derived from dry cupping along the back on each side of the vertebral column. In some cases, I have seen good effects follow the application of ice-bags to the injured part of the spine. At this period, I believe, medicine is of little service, beyond such as is required for the regulation of the general health on ordinary medical principles.

When the **Secondary Effects of Concussion of the Spinal Cord** have appeared, much may often be done not only for the mitigation of suffering, but for the cure of the patient, by carefully conducted local and constitutional treatment.

Rest, as in the early stages, must be persevered in; but, in addition to this, counter irritation may now be advantageously employed. The various forms in which this means is familiar to the Surgeon—stimulating embrocations, mustard poultices, blisters, and setons or issues—may be successively used.

With regard to internal treatment, I know no remedy in the early period of the secondary stage, when subacute meningitis is beginning to develop itself, that exercises so marked or beneficial an influence as the perchloride of mercury in tincture of quinine or of bark. I have seen this remedy produce the most beneficial effects, and have known patients come back to the Hospital to ask for the "perchloride" as the only medicine from which they had derived advantage. At a more advanced period, and in some constitutions in which mercury is not well borne, the iodide or the bromide of potassium in full doses will be found highly beneficial, more especially when there are indications of the presence and the pressure of inflammatory effusion.

When all signs of inflammation have subsided—when the symptoms have become those of paralysis, whether of sensation or of motion—but more especially in those cases in which there is a loss of motor power, with a generally debilitated and cachectic state, cod-liver oil, strychnine, and iron may be advantageously employed. But I would particularly caution against the use of these remedies, and more especially of strychnine, in all those cases in which inflammation is still existing, or during that period in any case in which there are evidences of this condition. In such circumstances the administration of strychnine is attended by the most prejudicial effects, increasing materially and rapidly the patient's sufferings. But in the absence of inflammatory irritation it will, if properly administered, be found to be most useful, more particularly in restoring lost motor power. In those cases in which strychnine may be advantageously administered, great benefit will also be derived from warm salt-water douches to the spine, and galvanism to the limbs.

At a more advanced period, when general cachexy has been induced, and more or less paralysis of sensation and motion continues in the limbs, and nothing of a specific nature can be done in the way of treatment, our whole object would be to improve the general health on ordinary medical principles, so as to prevent as far as possible the development of secondary diseases, such as phthisis dependent on malnutrition and a generally broken state of health, which may after several years lead to a fatal termination.

WOUNDS OF THE SPINAL CORD.

These injuries may occur from stabs with pointed instruments; from gun-shot violence; or, most frequently, from the pressure of fractured vertebræ. In the latter form of injury there is an association of wound and compression, giving rise essentially to the same symptoms as if the cord were divided.

Symptoms.—When the spinal cord is *completely divided*, certain symptoms occur that are common to all cases, at whatever part of the cord the injury has been inflicted, provided it be not so high as to cause instant death.

In the first place, there is *complete paralysis of sensation and motion* in all the parts below the seat of injury, though the mental state of the patient continue intact. The precise seat of injury may often be diagnosed by the extent of the paralysis. In injury of the lower part of the spine, there may be paralysis of all the parts supplied by the nerves of the sacral plexus, whilst those from the lumbar are not affected; the sensibility being lost below the knees, whilst above it is perfect—thus leading to the inference that the injury has been inflicted above the one and below the other set of nerves. When the paralysis is complete, the *temperature* below the seat of injury is *lowered*, often considerably, so

as to give a sensation of distinct coldness to the hand. This is also the case when the paralysis is partial, provided there be no sign of laceration of the cord. In cases of laceration a considerable rise of temperature has sometimes been observed, even as high as 114° F.; and after a time, a visible *diminution takes place in the nutritive activity of the limbs*, the circulation becoming feeble with a tendency to congestion at depending points. The lessening of nutritive vigor is not confined to the paralysed parts, but affects the whole system, the patient becoming speedily emaciated, anæmic, and cachectic. The skin assumes a dirty, cadaverous hue, and the cuticle usually exfoliates in branny flakes.

The lowering of the temperature, the disturbance in the processes of nutrition and secretion, and the supervention of emaciation and cachexy, are dependent upon a derangement of the relations of the vaso-motor system and the spinal cord. This derangement does not altogether arise from the simple division of the cord, but is rather the consequence of the inflammation set up in it and its membranes by the injury, and is, therefore, aggravated by anything that increases the inflammation; thus it is more marked in laceration of the cord and its continuous irritation by a fractured spine, than after its simple division with a cutting instrument.

The general symptoms of paralysis following injury present important modifications, according to the height at which the cord is divided.

1. When the injury has been inflicted in the **Lumbar or Lower Dorsal Region,** there is complete paralysis of all the parts supplied by the nerves given off from the sacral or lumbar plexuses, or both;—of the lower extremities, of the genital organs, and of the trunk as high as the seat of injury. There is always relaxation of the sphincter ani, with consequent incontinence of flatus, and, to a great extent, of fæces. There is at first, retention of urine in consequence of the paralysis of the bladder, which is unable to expel its contents; after a time, however, the urine dribbles away as fast as it is poured into the overdistended organ, the neck of which has lost its contractile sphincter-like action. The reason why there are incontinence of fæces and retention of urine in these cases, is this. The sphincter ani and the muscular fibres of the bladder are both voluntary and under the influence of the spinal system. When paraplegia exists, the restraining power of the sphincter ani and the expelling power of the bladder are both lost. Hence the bladder cannot expel its contents: while the anus cannot retain those of the intestines, which are brought down to it by the peristaltic movements which are not spinal, but under the influence of the sympathetic nervous system. After the first few days the urine becomes ammoniacal in odor, and alkaline in reaction. This is probably owing to changes that it undergoes after it has passed into the bladder, the mucous membrane of which becomes chronically inflamed, secreting a viscid alkaline muco-pus, which mixes with the urine. In the early stages of the accident, the penis will usually be observed to be in a state of semi-erection. Patients who have met with injuries of this portion of the spinal cord may live on for many months, and even for a year or two, falling into a cachectic state, but eventually die, usually with sloughing of the nates, or from the supervention of some intercurrent visceral inflammation of low type.

2. When the cord is divided in the **Upper Dorsal Region,** about the level of the third dorsal vertebra, we have not only the train of symptoms that have just been mentioned as characteristic of this injury lower down, but the respiration also is interfered with in consequence of the paralysis of the greater portion of the expiratory muscles. The intercostal muscles, and those constituting the abdominal wall, no longer

acting, imperfect expiration is solely effected by the elasticity of the walls of the chest; and the purely muscular expiratory movements, such as sneezing and coughing, cannot be accomplished. In these cases, during inspiration, which is effected almost exclusively by the diaphragm, the ribs are depressed instead of being expanded and raised; and the abdominal wall, which is soft and flaccid, is protruded far beyond its normal limits. In consequence of the impediment to respiration the blood is not properly arterialised, and slow asphyxia goes on, usually running into congestive pneumonia, and terminating fatally in about a fortnight or three weeks.

3. When the injury is situated in the **Lower Cervical Region**, not only do all the preceding symptoms occur, but there is paralysis of the upper extremities as well; and, the inspiration being entirely diaphragmatic, the circulation speedily becomes affected, the lungs surcharged and œdematous, the countenance assuming a suffused and purplish look. If the cord have been divided immediately above the brachial plexus, there will be complete paralysis of the whole of the upper extremities; but if the injury be opposite the sixth cervical vertebra, they may be only partially paralysed. This happened in two cases of fracture of the spine in this region that were some years ago under my care at the Hospital. In both, the paralysis existed on the ulnar but not on the radial side of the arms, owing to the external cutaneous median and musculo-spiral nerves arising higher from the plexus than the ulnar, and thus just escaping injury. It is remarkable that, in both these cases, there was acute cutaneous sensibility in the arms along the whole line of junction between the paralysed and the sound parts. There is this remarkable fact connected with injuries of the lower portion of the cervical spinal cord, that the temperature below the seat of injury often rises very considerably—to a higher point, indeed, than is noticed in any other surgical affection. Brodie found in one case that the thermometer marked 111° F. But in other cases again the temperature has been found greatly reduced, not more than 81° to 82° F. In cases of injury of the cord in this situation, death usually occurs by asphyxia in the course of from 48 hours to a week.

4. When the division of the spinal cord takes place **above the Origin of the Phrenic Nerves** opposite to or above the third cervical vertebra, instantaneous death results from the paralysis of the diaphragm, as well as of the rest of the respiratory muscles, inducing sudden asphyxia.

It necessarily happens in **partial division of the cord**, that the symptoms are not so clearly marked as in the instances that have just been recorded. Thus, for instance, the paralysis may not extend to all the parts below the seat of injury; it may be attended by severe pain in some of the semi-paralysed parts; or motion may be affected in one limb, and sensibility in another. These deviations may generally be explained by some peculiarity in the seat of the injury to the cord, or by the extent of its division.

MECHANICAL INJURIES OF THE VERTEBRAL COLUMN.

The mechanical injuries to which the vertebral column is liable, consist of Sprains or Wrenches, Fracture, and Dislocation.

Twists, Sprains, or Wrenches of the Spine, without fracture or dislocation of the vertebræ, may occur in a variety of ways. Boyer relates a fatal case, occurring from an injury received in practising gymnastics. Sir A. Cooper gives an instance of a fatal wrench of the spine, from a rope catching a boy round the neck whilst swinging. In two

cases, the injury also arose from violence applied to the cervical spine; in one from a railroad accident, in the other from a fall from a horse.

These wrenches of the spine are, from obvious reasons, most liable to occur in the more mobile parts of the vertebral column, as the neck and loins, just above the sacral region; less frequently in the dorsal region.

In railway collisions, when a person is violently and suddenly jolted from one side of the carriage to the other, the head is frequently forcibly thrown forwards and backwards, moving as it were by its own weight, the patient having for the time lost control over the muscular structures of the neck. In such cases the patient complains of a severe straining, aching pain in the articulations between the head and the spine, and in the **Cervical Spine** itself. This pain closely resembles that felt in any joint after a severe wrench of its ligamentous structures, but is peculiarly distressing in the spine, owing to the extent to which fibrous tissue and ligament enter into the composition of the column. It is greatly increased by to-and-fro movements, however slight, and especially by rotation; also by pressure upon, and by lifting up the head so as to put the tissues on the stretch. In consequence of this, the patient keeps the neck and head immovable, rigid, looking straight forwards. He cannot raise his head off a pillow without the assistance of his own hand, or that of another person.

The **Lumbar Spine** is often strained in railway collisions, with or without similar injury to the cervical portion of the column, in consequence of the body being forcibly swayed backwards and forwards during the jarring oscillations of the carriage on the receipt of a powerful shock. In such cases the same kind of pain is complained of. There is the same rigidly inflexible condition of the spine, with tenderness on external pressure, and great aggravation of suffering on movement, more particularly if the patient bend backwards. The patient is unable to stoop; in attempting to do so, he always goes down on one of his knees.

The muscles and fasciæ at the back are also often stretched and torn, in cases of twists and strains of the ligaments of the spinal column. There may therefore be swelling and induration of these tissues from the presence of inflammatory effusions and inability to use the muscles. But the great danger of these strains of the spine is, that they are not unfrequently associated with some of the most serious affections of the spinal cord that are met with in surgical practice as a consequence of injury. They may of themselves prove most serious, or even fatal.

The **Prognosis** will depend partly on the extent of the stretching of the muscular and ligamentous structures, partly on whether there is any inflammatory action excited in them which may extend to the interior of the spinal canal. As a general rule, where muscular, tendinous, and ligamentous structures have been violently stretched, as in an ordinary sprain, however severe, they recover themselves in the course of a few weeks, or at most within three or six months. If a joint, as the shoulder or ankle, continue to be weak and preternaturally mobile, in consequence of elongation of the ligaments, or weakness or atrophy of the muscles, beyond this period, it will, in all probability, never be so strong as it was before the accident. The same holds good with the spine; and a vertebral column which has been so weakened as to require artificial support, after several months, in order to enable it to maintain the weight of the head, will probably never regain its normal strength.

One great prospective danger in strains of the spine is the possibility of the inflammation developed in the fibrous structures of the column extending to the meninges of the cord. This I have several times seen.

It is particularly apt to happen when the strain or twist occurs between the occiput and the atlas or axis. In these cases a rigid tenderness is gradually developed, which is most distressing and persistent, and evidently inflammatory. Or the paralysis may be confined to the nerves that are connected with that part of the spine that is the seat of the wrench, one or other of their roots either having suffered lesion, or the nervous cord itself having been injured in its passage through the intervertebral foramen. Lastly, a twist of the spine may slowly and insidiously be followed by symptoms of complete paraplegia, and eventually by death from extravasation of blood into the vertebral canal.

The *Treatment* of these injuries is the same as that of concussion of the spinal cord (see page 576).

Fracture of the Spine may occur either by the application of direct violence, or by a violent twist or bend of the body forwards. Direct violence, as a blow, fall, or gun-shot injury, may of course fracture the spine at any part and almost to any extent, in some cases merely detaching a spinous process, in others splintering and comminuting several vertebræ and lacerating or dividing the spinal cord. Fracture of the spine from a violent but forcible bend of the body forwards chiefly occurs in the cervical region. It is usually produced by a person falling from a height on the head, the body being bent forcibly forward so as to drive the chin against the sternum. This accident often happens in falls from horseback, or in taking a "header" into shallow water. In some cases it has occurred from a person sitting on the top of a vehicle having the head forcibly bent down whilst passing under an archway. In these accidents there are usually extensive rupture of the spinal ligaments and displacement of the bones, as well as fracture.

The extent of the fracture and the amount of displacement necessarily vary greatly. The spinous process merely may be broken off; or the arch may be broken through on each side of the spine; or the fracture may extend through the body of the vertebra.

In some cases of even very extensive fracture there may be no appreciable displacement: but usually some change of position ensues, in many cases to such an extent as to compress or lacerate the spinal cord. The mode of occurrence of the fracture will influence the amount of displacement. If the fracture be through the arch, or consist in a simple detachment of the spinous process by a fall or a blow on the back, there may be little or no displacement. If it occur from gun-shot injury, or from a fall upon the head, or by forcible flexure of the neck and body forwards, as when the body is compressed between the top of a van and an archway, then there will probably be great displacement, and perhaps separation of the articulating surfaces of contiguous vertebræ.

The **Signs** of this injury vary very greatly, and depend in a great degree upon the extent of the displacement. If this be inconsiderable, it may be extremely difficult, and even impossible in some instances, to pronounce with certainty whether the spine has been broken or not; the more so, if the fracture do not implicate the body of the vertebra. If, on the other hand, the displacement affect the axis of the column or compress the cord, the symptoms are so marked as to admit of easy diagnosis. The symptoms are of two kinds; those presented by injury of the bone, and those dependent on injury by compression or laceration, or both, of the spinal cord.

The **Local Signs** are usually pain at the seat of injury, greatly increased on pressure or on moving the part; inequality of the line of the

spinous processes, with depression of the upper portion of the spine, and corresponding prominence of the lower. There is an inability to support the body in the erect position, and to move the spine in any way; hence, when the upper portion of the column is injured, the patient holds his head in a stiff and constrained attitude, fearing to turn it to either side.

The **General Symptoms** of fracture of the spine are dependent upon the injury which the cord has received. If the fracture have not implicated the spinal canal, as when only the tip of a spinous process has been broken off, or if it be unattended by displacement, although it may traverse the body and arches, no symptoms depending upon the injury of the cord need exist, and indeed occasionally they are absent. But even in these cases there is usually some paralysis, owing perhaps to the concussion to which the cord has been subjected at the moment of injury; and occasionally a sudden movement by the patient will bring on displacement, by which the cord is compressed and all the parts below the injured spot are paralysed. A woman was admitted into University College Hospital with an injury of the neck, the nature of which could not be accurately ascertained. She was in no way paralysed, but kept her head immovable in one position. A few days after admission, whilst making a movement in bed, by which she turned her head, she fell back dead. On examination, it was found that the spinous process of the fifth cervical vertebræ had been broken off short, and was impacted in such a way between the arches of this and the fourth as to compress the cord. This impaction and consequent compression probably occurred at the time of the incautious movement, thus producing immediate death. When there is only partial displacement, there may be but incomplete paralysis of the parts below the injury; of one arm, one leg, &c. In these cases there is usually great pain at the seat of fracture, and extending from it along the line of junction between the paralyzed and sound parts round the body or along the limb. This symptom, which is of great importance as exactly defining the seat of injury, is due, as I found in dissecting a case of fracture of the sixth cervical vertebra under my care, to the fractured bone compressing and irritating the nerve that issues from the vertebral notch opposite the seat of injury.

When the cord is implicated, the symptoms will vary according to the seat of the injury and the extent of the damage. For a detailed account of the symptoms presented by injuries of the different portions of the cord, the reader is referred to the section on "Wounds of the Spinal Cord" (p. 578).

In the majority of cases of fracture of the spine, there is such displacement of the bone as to compress the whole thickness of the cord, and thus to occasion complete paralysis of motion and sensation in the parts below the seat of injury. This paralysis resembles that which arises from simple division of the cord, but is followed by greater impairment of nutrition, as is shown in wasting cachexy, a tendency to sloughing, and alkaline urine. The reason of this difference is, that in fracture the cord is not simply compressed or divided, but is continuously irritated by the edges of broken bone, and thus not only becomes incapable of healing, but is kept in a state of chronic irritation and inflammation. If the fracture be above the origin of the phrenic nerve, respiration will be arrested and the patient die instantaneously.

Prognosis.—Although fracture through the body of a vertebra is generally fatal, it is not always, and instances have been known where

the broken bone united, and the patient lived months or even years afterwards; but fractures of the spine through the bodies of the vertebræ, with displacement, are inevitably fatal. Death occurs in three different ways. It happens primarily and instantaneously, as the direct and immediate consequence of injury, in all those cases in which the fracture is above the origin of the phrenic nerve. It occurs secondarily and indirectly, at a more or less remote period, as the result of changes in the body dependent on permanent loss of innervation, in all cases in which the injury sustained by the cord is below the part, the integrity of which has just been referred to as essential to the maintenance of life. At the seat of injury, of compression, and of disorganization, inflammation is necessarily developed; thence it spreads along the membranes and to the cord itself to a variable distance, giving rise to effusion into the canal and softening of the medulla. It is doubtless by the gradual extension upwards of these secondary inflammatory disorganisations, that death is ultimately occasioned; the mischief, when low down, leading to impairment of the actions depending upon the integrity of the cord, and, when high up, extending to the origins of the phrenic nerves, and so arresting respiration.

The **Treatment** of these injuries is sufficiently simple. No attempt at reduction can of course be made. All our efforts must be directed to the prolongation of life. With this view, if this fracture be in such a situation, at any point below the upper dorsal vertebræ, for instance, as will hold out a prospect of life being prolonged for a few weeks or months, means must be taken to prevent the occurrence of sloughing of the nates, an accident that is common, and usually fatal, in these cases; and every precaution should be taken to keep the bladder healthy, one of the great dangers in cases of fracture of the spine being the supervention of cystitis, which may gradually extend upwards till the kidney becomes involved. The patient should be laid at once on a water-bed, cushion, or mattress; he must be kept scrupulously clean, and his urine should be drawn off twice in the day at regular hours. If, as usually happens after a time, the bowels become confined, relief must be afforded by castor-oil or turpentine enemata. A nourishing diet must be administered and perfect rest in one position enjoined. In this way life may be maintained for a considerable length of time; and ossific union of the fracture may sometimes take place, though the patient may not recover from the paralysis, and will die eventually from disease of the cord. But in some cases a much more satisfactory result is obtained; the patient gradually gains power in the paralysed parts. In these cases much assistance will be afforded him by his wearing an apparatus as in Fig. 254, consisting of a firm pelvic band, with a strong iron rod shaped to the spine, and running as high as the vertex, having padded transverse arms to support the head and shoulders, and the whole attached to a stout leather case moulded to the back and shoulders.

Fig. 254.—Apparatus for Fracture of the Spine.

Trephining the Spine.—As the fatal result of fracture of the spine is almost inevitable, and as it is undoubtedly dependent upon the compression or division of the cord by the broken vertebra, the idea has naturally suggested itself to Surgeons that life might be prolonged, and health perhaps restored, if the same operation were extended to the

spine which is successfully employed in parallel cases of injury of the head; viz., the elevation and removal, if necessary, of the depressed portion of bone. This operation, originally proposed by Heister, was first performed by Louis and Cline. It may be done as follows. The patient lying on his face, a free incision, several inches in length, from three to five, according to the extent of the injury, is made along the line of the spinous processes, and the muscular masses on each side of the spine are dissected away, so as to expose the osseous surfaces. The spinous processes, at the seat of injury, should then be successively seized with strong forceps, and gently but firmly moved, in order to see whether there be fracture at the base or supporting arches. If a portion of bone be completely broken off, it may, after all ligamentous connexions have been severed, be raised by the forceps or an elevator. Should one arch only be broken through, the uninjured one may be divided by cutting pliers or a Hey's saw; or, should both be unbroken, the Surgeon may, if he think it prudent to proceed further, divide both in this way, and so remove them and the spinous processes, and expose the theca of the cord. After the operation the wound is to be simply dressed and the patient kept in the prone position.

The results of this operation are not very encouraging. It has been performed by various Surgeons in different countries, but chiefly in America, about thirty times; and, although some temporary advantage seems to have occurred in a few of the cases, permanent success has only been obtained in one instance by Gordon of Whitworth Hospital, Dublin, but even in this case the paralysis remained. But, though so far the result has been but little satisfactory, ought Surgeons to discard the operation? I think not: because, as fracture of the spine with serious lesion of the cord cannot be recovered from, and has an almost invariably fatal termination, and as the evil consequences of the fracture are dependent not only upon the primary lesion of the cord, but on the secondary disorganising and inflammatory processes set up in it by the continued irritation of the fractured fragments, we are justified in attempting the removal of this source of certain misery and impending death by the only means in our power—operative procedure; and we are the more justified in this course, as the operation is not necessarily dangerous, does not appear often to have hastened death, and has certainly, in some cases, afforded most marked relief, the paralytic symptoms disappearing to a great extent, and the patient being able to move limbs that were previously motionless.

One serious objection that has been urged against the operation must not, however, be overlooked. It is, that in the great majority of cases the fracture of a vertebra is through the body and not through the arches. This undoubtedly is so, and it is this circumstance that has rendered the operation as yet little more than a means of giving relief when the cord is partially divided and lacerated by being stretched over a rough and jagged edge of the broken body of a vertebra thrust back against it. Little more than temporary relief can be expected from the removal of the pressure from behind by cutting away the arches. But, when these portions only of the spinal column are fractured and displaced, a rare condition it is true, then permanent good may be expected to follow the operation. If signs of such injury exist, as evidenced by distortion or depression of one or more spinous processes, it would most certainly be quite proper for the Surgeon to adopt the only means in his power of affording relief. The principal danger, and usual cause of death after cutting away a portion of the spine is, undoubtedly, either

the continuance of the inflammation excited by the injury in the cord and its membranes, or its increase or development by the operation itself.

Dislocations of the Spine.—On looking at the arrangement of the articular surfaces of the vertebræ, the very limited motion of which they are susceptible, and the way in which they are closely knit together by strong ligaments and short and powerful muscles, it is obvious that dislocations of these bones must be excessively rare. So seldom, indeed, do they occur that their existence has been denied by many Surgeons. Yet there are a sufficient number of instances on record to prove that these accidents may happen. Those cases that have been met with have usually been associated with partial fracture, but this complication is not necessary. In all, the displacement was incomplete; and, indeed, a complete dislocation cannot occur. Fracture may occur anywhere in the spine, but dislocation without, or with very slight, fracture is exceedingly rare. Dislocation of the spine may occur in the following parts. 1. Between the occiput and atlas. This is very rare. 2. Between the atlas and axis. This, though rare, is much less so than the preceding, and may occur with or without fracture of the odontoid process; and when the odontoid process is broken, death at once ensues. 3. Dislocation between the second and third cervical vertebræ is very rare, as rare as dislocation between the atlas and axis. 4. Dislocation generally happens somewhere between the fifth and seventh cervical vertebræ. Dislocation without fracture cannot occur in the dorsal region, but may occur in the lumbar region. A person either has his head crushed downwards and forwards between his shoulders, or falls on his head and then rolls over.

In Fig. 255 we have an instance of dislocation of the fifth from the sixth cervical vertebra, with the separation only of a scale of bone which was adherent to the intervertebral fibro-cartilage. The patient had fallen on his head from a van and died of asphyxia in twenty-four hours.

Fig. 255.—Dislocation between the Fifth and Sixth Cervical Vertebra.

Fig. 256.—Dislocation of the Axis from the Third Cervical Vertebræ.

The spine may be so seriously injured that dislocation is at any moment imminent, and yet the patient may live for some days before the dis-

placement occurs, by which the cord is compressed. A man was admitted into University College Hospital, who had been crushed by falling between the platform and a train in motion. Amongst other severe injuries he had paralysis of the circumflex and musculo-spiral nerves of the left arm, but no hyperæsthesia. On the third day, whilst being moved in bed, his head fell to one side, and he suddenly died. On examination after death, it was found that the second vertical vertebra, carrying the atlas and head with it, had been dislocated from the third (Fig. 256); the connecting ligaments being completely torn through on the left side, so that the head falling to one side had caused fatal compression of the cord.

Dislocation of the Atlas from the Occipital Bone has been described in two instances only—by Lassus and by Paletta. In the case by Lassus, death ensued in six hours, and the right vertebral artery was found to be ruptured. In the other case, the patient is said to have lived for five days, but the report is so incomplete that little value can be attached to it.

Dislocation of the Axis from the Atlas is of more frequent occurrence. It may happen with or without fracture of the odontoid process. In either case, the axis is carried backwards and the spinal cord thus compressed. This accident is said to have been caused by a person in play lifting a child off the ground by its head; the combination of rotation and traction in this movement being especially liable to occasion the accident. For the same reason, it has been met with in those who have been executed by hanging. Death would probably be instantaneous in these circumstances. It has, however, been stated that, in dislocations of this kind, life has been saved by the Surgeon placing his knees against the patient's shoulders, and drawing or twisting the head into position. This, however, I cannot believe possible if the displacement have been complete, as death must be instantaneous, the cases of supposed dislocation and reduction having probably been instances of concussion of the cord with sprain of the neck.

Dislocation of any one of the five Lower Cervical Vertebræ may occur. The third vertebra is least frequently dislocated; the fifth is more commonly displaced (Fig. 255). These injuries are usually associated with fracture; sometimes, though rarely, they happen without this complication. In these dislocations, as in those that have already been described, the displaced bone carries with it the whole of that portion of the vertebral column which is above it, no single bone being dislocated either among those above or those below the displacement.

In dislocations, the articulations between the two vertebræ are torn open. The supraspinous and interspinous ligaments, the ligamenta subflava, and the common posterior ligament, are torn through, so that the spinal canal is opened. The intervertebral fibro-cartilage may be torn, or it may be entire, and a scale of the body of the subjacent vertebra be detached. When the spine above the dislocated part is bent forwards, a wide gap is visible posteriorly, at the seat of injury.

Causes.—The causes of dislocation are numerous, but may be enumerated as follows. 1. A person standing in a cart and driving under an archway finds, too late, that he is too tall to clear the archway; he bends forwards, but, miscalculating the distance, his head is pressed violently forwards; the supraspinous and interspinous ligaments are torn, and perhaps the intervertebral fibro-cartilage is ruptured, or torn off from the subjacent bone, and detaches with it a lamina of that bone. 2. A person takes a header into shallow water; his head comes against the bottom, he rolls over, and his spine is broken or dislocated. Such accidents are

not very unfrequent. I have seen several cases of paralysis, but not of death, resulting from this kind of accident. Sometimes a child is held up by the chin and the back of the head; the child struggles and the odontoid process gives way, and dislocation occurs between the first two vertebræ.

These accidents most commonly happen from forcible flexion of the neck forwards, though traction and rotation conjoined have occasioned them. In a case of luxation of the sixth and seventh cervical vertebræ recorded by J. Roux, the accident happened to a sailor plunging into the sea for the purpose of bathing, and coming head foremost against a sail which had been spread out to prevent the attack of sharks; he died on the fourth day. In a patient of mine, who fell out of a window in such a way that the head was doubled forwards upon the chest, and who was brought to the Hospital with supposed fracture of the spine, we found after death, which occurred on the fifth day, that the seventh cervical vertebra, carrying with it the upper portion of the spine and the head, had been dislocated forwards from the first dorsal, there being a wide gap posteriorly between the laminæ of these bones, with horizontal splitting of the intervertebral substance, detaching with it an extremely thin and small layer of bone from the body of the seventh vertebra. There was no fracture about the articular processes, which were completely separated from one another. In the instance already referred to, in which a man fell on his head from a van, and death resulted in 24 hours, a similar displacement was found of the fifth from the sixth cervical vertebra, with compression of and hæmorrhage into the substance of the medulla, and disorganisation of it to the extent of nearly an inch opposite the seat of dislocation, where it had been injured by the forward pressure of the dislocated vertebra.

The *Symptoms* of these accidents are necessarily excessively obscure, being very liable to be confounded with those of fracture.

Reduction has been effected in a sufficient number of cases of this kind to justify the attempt being made when danger is imminent.

Dislocation of the Transverse Process of the Cervical Vertebræ occasionally occurs. The patient, after a sudden movement, or a fall on the head, feels much pain and stiffness in the neck, the head being fixed immovably, and turned to the opposite side to that on which the displacement has occurred. In these cases I have known *Reduction* effected by the Surgeon placing his knees against the patient's shoulders, drawing on the head, and then turning it into position, the return being effected with a distinct snap.

In the **Dorsal Region**, dislocation of the spine, though excessively rare, may occur; seldom, however, without being accompanied by fracture. The last dorsal vertebra has been several times found dislocated from the first lumbar with rupture of the intervertebral fibro-cartilage. In these cases, however, there has usually been found fracture of the transverse processes of the first lumbar vertebra, or, as in an instance recorded by Sir C. Bell, fracture of its body.

I am not acquainted with any case in which dislocation without fracture of the *Lumbar* spine has been observed.

The **Symptoms** presented by dislocations of the spine are, like those of fracture, dependent on the degree and seat of the injury inflicted on the spinal cord. And death will ensue at varying periods, according to whether the dislocation be above or below the origin of the phrenic nerves, in accordance with those rules that have been laid down at p. 580.

The **Diagnosis** between a dislocation and a fracture of the cervical spine is not easily made. But there is one symptom which, according as it is present or not, may throw much light on this point. It is the occurrence of pain, amounting to hyperæsthesia, along the line of junction between the paralysed and unparalysed parts. In fracture this will be commonly found to be present (p. 583). In dislocation, where the nerves are not irritated or lacerated in their exit through the spinal column, it is absent.

The **Treatment** of dislocation of the spine, except in the case of the transverse processes, resembles in all important respects that of Fracture of the vertebral column.

CHAPTER XXVI.

INJURIES OF THE FACE AND ADJACENT PARTS.

Face.—Cuts about the *Cheeks and Forehead* are of common occurrence. These injuries present nothing peculiar, except that the structures of the face show the same ready disposition to repair, as well as to the supervention of erysipelatous inflammation, that characterises the scalp when injured.

In the *Treatment* of these wounds, it is of much consequence to have as little scarring as possible. The edges, after being well cleaned, should be brought neatly into apposition by fine hare-lip pins and twisted suture, or by a few points of interrupted suture; more particularly if the wound be transverse, and implicate the lips or nose. When the wound is in the neighborhood of the eyelids, especial care must be taken to prevent any loss of substance, lest the contraction of the cicatrix produce eversion of the lid. In those cases in which a portion of the nose or lip has been lost, much may be done to repair the deformity by properly conducted plastic operations, such as will be described in Chapter LVIII. The bleeding, which is usually very free in wounds of the face, in consequence of the division of some arterial branch, may often be arrested by passing the hare-lip pin under the vessel, and applying the twisted suture above it, so that it may be compressed.

If the *Lip be cut from within*, by being struck against the teeth, the coronary artery may be divided, the patient swallowing the blood that flows into the mouth. Some years ago, a man was brought to the Hospital drunk, and much bruised about the face. Shortly after his admission he vomited a large quantity of blood, which was at first supposed to proceed from some internal injury; but, on examining his mouth, it was found that the blood came from the coronary artery of the lip, which was divided with the mucous membrane.

Parotid Duct.—It occasionally happens in wounds or abscesses of the cheek that the parotid duct is divided, in consequence of which the wound does not close, and a trickling of saliva takes place upon the outside of the cheek, so as to establish a **Salivary Fistula**, a source of much disfigurement and inconvenience. The surface around it is puckered and somewhat excoriated, and the fistula opens by a granulating aperture.

If this condition be recent, a cure may sometimes be accomplished, by

paring the edges of the external wound, bringing them into close apposition, and applying pressure upon the part. If it be of old standing, the probability is that the aperture into the mouth is closed, and that something more will be required than bringing the lips of the wound together. With this view, the operation that will be described in Chapter LV. must be had recourse to.

Besides the fistula of the Stenonian duct, other fistulous apertures may occur in the cheek, as the result of injury or disease, allowing the escape of a small quantity of saliva. These openings are always healed with difficulty: the edges becoming callus, and not readily taking on reparative action. Closure may be effected in some cases by cauterisation with nitrate of silver, or with a red-hot wire, due attention being paid to the general health. In other cases, the electric cautery may prove successful. If, however, the opening be free, with much indurated structure about it, it may be necessary to excise a portion of the edges before bringing them together.

Nose.—**Foreign Bodies**, such as pebbles, beads, dried peas, &c., are occasionally met with in the nostrils of children, having been stuffed up in play, and becoming so firmly fixed as to require extraction by the Surgeon. For this purpose a pair of urethral or polypous forceps will usually be found convenient. In some cases, however, a bent probe or an ear-scoop will remove the impacted body most easily.

The Ears are not unfrequently *wounded* in injuries of the head and scalp; a portion of the external ear being sometimes torn down and hanging over the side of the face. In these cases, as in scalp-injuries, the part should never be removed, but, however lacerated and contused, should be cleaned and replaced by means of a few points of suture and strips of plaster. When the cartilaginous portion of the ear is divided, nice management is usually required in effecting perfect union.

Foreign Bodies are often pushed into the ears of children. When pointed or angular, such as pieces of stick, they may readily be extracted with forceps; but when round and small, such as pebbles or beads, they are not so easily removed.

Fig. 257.
Ear Scoop.

The foreign body may occasionally be removed by passing the bent ear-scoop round it. In some cases I have found an instrument (Fig. 257) made by Coxeter on the model of Civiale's urethral scoop, useful in extracting a foreign body from the ear. It can be introduced straight and then passed beyond it, when, by the action of a screw in the handle, the scoop is curved forwards, and so enables extraction to be readily effected. But, as a rule, it is bad practice to attempt to remove foreign bodies from the ear by means of instruments; in the majority of cases the offending body is best removed by forcibly syringing the ear with tepid water, injected by means of a large brass syringe, in a full stream, the pinna being drawn up so as to straighten the external meatus. In this way the bead or pebble is soon washed out by the reflux of the water striking against the tympanum. It may be laid down as a good general rule, that if a round or oval body cannot be dislodged by syringing it will not be removed by instruments, and if the proper use of the syringe do not suffice, it is better to leave matters alone, and to allow the foreign body to become loosened, than to poke instruments into the ear with the view of forcibly extracting it. These attempts are ill-advised; and I have known death

to follow prolonged and unsuccessful efforts at the extraction of a pebble from the ear.

ORBIT.—**Injuries of the Orbit** may be dangerous, either to the brain or to the eye. If wounds be deep and directed upwards, they are always serious, on account of the proximity of the brain; thus a pointed body, such as a piece of stick, the end of an umbrella, or a knife thrust into the orbit, may perforate its superior wall, and produce a fatal wound of the brain. The injury to the brain through the orbital plate of the frontal bone may be fatal by the cerebral inflammation that is induced; or the thrust may extend deeply, and, lacerating the internal carotid artery, occasion fatal hæmorrhage. In one remarkable case recorded by Nélaton, a young man was wounded by the thrust of the point of an umbrella in the orbit; the cavernous sinus and internal carotid artery on the opposite side were wounded, an arterio-venous aneurism formed, the eyeball became prominent, and death from hæmorrhage eventually resulted from the giving way of the aneurism. Occasionally inflammation is set up in the loose cellulo-adipose tissue contained in the orbit, giving rise to abscess which may point in either eyelid; or to inflammation which may extend to the encephalon. In other cases, wounds of the orbit may be followed by loss of vision, without the eyeball being touched; either in consequence of injury of the optic nerve, or at a latter period from the division of some of the other nerves of the orbit producing sympathetic amaurosis, as occasionally happens even from ordinary wounds of the face implicating some of the terminal branches of the fifth pair.

EYEBALL.—Injuries of the eyeball are so commonly followed by impairment or total loss of vision, as to constitute a most important series of accidents; the delicacy of the structure of this organ being such, that injury of it is often followed by complete opacity of the lens or other media and loss of sight. The impairment of vision may be the result of direct violence applied to the organ, injuring its more transparent parts or displacing the lens; or it may arise indirectly from various causes which will be presently described.

The injuries of the eye produced by *direct violence*, may be divided into contusions and wounds.

Contusion of the Eyeball, without rupture or apparent injury of any of its structures, may give rise to such concussion of the retina as to be followed by temporary or permanent amaurosis. More frequently contusions of the eye are accompanied by extravasation of blood under the conjunctiva, and much ecchymosis of the eyelids. A "black eye" is best treated by the continuous application of a weak spirit lotion.

Contusion of the Eye with Rupture of some of the Structures of the Ball is a most serious accident. The cornea may be ruptured, the humors lost, and vision permanently destroyed. Most frequently the rupture is internal, the outer tonics escaping all injury. In this case we may have an extravasation of blood into the eyeball, completely filling the anterior chamber, hiding and complicating deeper mischief within the globe; or there may be hæmorrhage into the vitreous body, with or without detachment of the retina. This condition, termed **hæmophthalmia**, is frequently associated with separation of the ciliary margin of the iris. In other cases, the crystalline lens may be driven into the vitreous humor, be engaged in the pupillary aperture, or fall forwards into the anterior chamber. As a consequence of such injuries, the eye usually becomes inflamed, with intense frontal and circumorbital pain; disorganization of the ball, and ultimate loss of vision ensuing.

The *Treatment* must always be of an active antiphlogistic character.

Blood should be freely taken from the arm by venesection, and from the temple by cupping, the iris being dilated by the instillation of a solution of the sulphate of atropine, of the strength of two grains to an ounce of distilled water; the patient must be kept in a darkened room, on a strictly antiphlogistic regimen, and should be put under the influence of calomel and opium as speedily as possible. In this way the inflammation will be subdued, the effused blood absorbed, and perhaps vision restored. In some cases, however, opaque masses and bands of lymph will be deposited in the anterior chamber and the pupillary aperture, preventing more or less completely the entry of light. If the lens be displaced into the posterior chamber, it must be left there; if into the anterior, it may be extracted through the cornea.

Wounds of the Eyeball may be divided into those that are merely superficial, and do not penetrate into its chambers; and those that perforate its coats.

Non penetrating Wounds are usually inflicted by splinters of iron, or other metallic bodies, which become fixed in the cornea, or between one of the eyelids and the ball. Very painful and troublesome injuries are sometimes inflicted by scratches of the eyeball with the nails of children.

In the *Treatment* of these superficial injuries, the first point is necessarily to remove any foreign body. If it be fixed on the cornea, as commonly happens, it may be picked off with the point of a lancet or cataract-needle, or a "spud;" if it be a splinter of iron that has been so lodged, it is well to bear in mind that a small brown stain will be often left after the metallic spiculum has been taken off; this, however, will disappear in the course of a few days. In order to remove foreign bodies lodged between the ball and the eyelids, the latter must be everted so that the angle between the palpebral and the ocular conjunctiva may be properly examined. For this purpose the lower eyelid need only be drawn down, whilst the patient is directed to look up; but the eversion of the upper eyelid requires some skill. It is best effected by laying a probe horizontally across it, immediately above the tarsal cartilage; the Surgeon then, taking the eyelashes and ciliary margin lightly between his finger and thumb, draws down the eyelid at the same time that he everts it by pressing the probe firmly backwards and downwards against the eyeball; the patient should then look down in order that the whole of the upper part of the conjunctiva, where the foreign body will probably be found, may be carefully examined.

Penetrating Wounds of the eyeball present great variety; they are commonly inflicted by bits of stick, steel-pens, children's toys, and not unfrequently during the shooting season by the explosion of faulty percussion-caps, or the lodgment of a stray shot in the eye. In all cases these accidents are highly dangerous to vision; and, when the foreign body lodges, sight is usually permanently lost. The danger usually arises either from the eye being opened to such an extent that the humors escape, or else that, the iris becoming engaged in a wound in the cornea, a hernial prolapse of it occurs. The more remote effects usually arise from inflammation taking place within the globe, so as to produce an opaque cicatrix of the cornea or of the capsule of the lens; or else adhesions may form, stretching across between the iris and the lens, or between these parts and the posterior surface of the cornea; or inflammation may take place in all the structures of the ball, giving rise to rapid and deep organisation.

The *Treatment* of penetrating wounds is strictly antiphlogistic. Bleed-

ing in the arm, cupping on the temples, low diet, a darkened room, and the administration of calomel and opium, are the principal points to be attended to. If the iris have protruded through a wound in the cornea, it should be carefully pushed back, and a drop or two of the solution of atropine put upon the eye. If it cannot be returned, it may be removed with a pair of fine curved scissors; and, at a later period, any staphylomatous tumor that may form should be touched repeatedly with a pointed piece of nitrate of silver. If there be a tendency to the formation of adhesions, or to the deposit of lymph within the pupil or the anterior chamber, our principal reliance should be upon small doses of calomel, in conjunction with opium. If the lens or its capsule have become opaque, traumatic cataract thus forming, extraction may be required at a later period of the case.

If the eye be so extensively opened or deeply injured that vision is irreparably lost, and extensive suppurative inflammation in it and in the structures of the orbit is threatened, the sooner the globe is extirpated the better: the patient being thus saved much local and constitutional disturbance, and the danger of sympathetic affection of the other eye being diminished.

Indirect Injury of the Eye often follows injuries of the nervous system. Thus impairment of vision may be produced by concussion of the eye-ball through blows on the head; by injuries of the face implicating the fifth pair of nerves; by injury of the spine; or by injury of the sympathetic.

Concussion of the Eye may be produced by a direct blow on the organ; or it may be the result of a blow on some other part of the head or face. In the latter case, the injury is dependent on the transmission of the force through the bones of the head or face to the structures within the orbit. The resulting impairment of vision is at its worst at the moment of the injury, and either slowly disappears, or becomes permanent in consequence of the development of structural changes in the eye.

That indirect violence may produce serious lesion of the eye, is evident from the fact that the lens has been in this way dislocated without any direct injury having been inflicted on the eye itself. Deyber relates a case in which cataract was induced by a wound of the eyebrow from a stone, the eye itself being otherwise uninjured: and I have seen cataract occur in an otherwise healthy woman aged 40, three or four months after the receipt of a blow on the malar bone in a railway collision. It also often happens that, in cases of a general shock to the system, obscuration and impairment of vision gradually manifest themselves. (See p. 570 *et seq.*)

When impairment of vision remains permanent, or is gradually developed, after concussion, it is due to interference with the nutrition of the structures of the eye. In such cases, atrophy of the optic disk may often be discovered by ophthalmoscopic examination. The development of cataract after blows on the eyebrow or cheek is to be accounted for by the frontal or infraorbital branches of the fifth nerve being implicated and irritated, so as to impair the nutrition of the globe.

The eye may also suffer in consequence of **Wound or Irritation of the Branches of the Fifth Pair of Nerves.**[1] This has long been observed. Hippocrates speaks of loss of vision consequent on wounds

[1] See "Concussion of Spine," Lecture X., p. 233 *et seq.*, Longmans, 1875, for a full account of these injuries.

of the eyebrow; and makes the very accurate observation that the impairment is less when the wound is recent, but increases as cicatrisation advances. Fabricius Hildanus and La Motte relate cases in which blindness followed wounds of the outer angle of the orbit. Morgagni relates the case of a lady who, in consequence of the overturning of a carriage, was wounded by some splinters of glass in the upper eyelid. The eyeball was uninjured: but vision became gradually impaired, and was almost lost by the fortieth day after the accident.

It is by no means necessary for the production of impaired vision after injury of parts of the fifth nerve, that there should be an actual wound: a simple contusion is sufficient. Wardrop states that it is only where the frontal nerve is wounded or injured and not divided, that amaurosis takes place. Indeed, in some cases, amaurosis has been cured by division of the nerve after its partial injury. That it is the irritation, and not complete division of the nerve, that leads to loss of vision, is in accordance with the view of Brown-Séquard, that the immediate effects of section of a nerve are very different from those which are observed as the result of its irritation.

The loss of vision may come on instantaneously, as in a case related by Wardrop of a sailor struck by a ramrod on the eyebrow; after a few days, as in a case recorded by Chelius where the loss of vision came on eight days after a blow in the eyebrow; or after a longer lapse of time, as in most of the recorded cases. In the great majority of cases the impairment of vision is at first slight, and gradually goes on to complete loss of sight.

In what way can irritation of a branch of the trifacial nerve, unaccompanied by any direct injury of the eyeball or the structures of the orbit, produced instantaneously or remotely loss of vision? Some observers have attributed this to the propagation of irritation along the sheath of the nerve to the trunk of the opthalmic division, and thence along to the sheath of the optic nerve and the retina. But there is no evidence of such a propagation; and this explanation would not account for those cases in which blindness suddenly supervened. That injury of the fifth nerve produces important changes in the eye, has been incontestably determined in late years by the experiments of Snellen, Schiff, Buttner, Messner, and others; and whether we explain the morbid changes that occur in the eye as a consequence of the injury of the nerve by the supposition that "neuro-paralytic" inflammation is set up in the globe, or suppose that the surface by losing its sensibility becomes more liable to the action of external irritants, matters little to the practical Surgeon.

Wardrop says that "the distribution of the first branch of the fifth pair of ophthalmic branch explains how wounds of the frontal, infraorbital, and other branches of nerves which form anastomoses with the ophthalmic ganglion, are sometimes followed by amaurosis." No doubt it is to the intimate connexions that exist between the frontal nerve, the ophthalmic division of the fifth, and the sympathetic and ciliary nerves, that we must refer these various morbid phenomena resulting from its irritation. In what way this irritation of the frontal nerve exercises an injurious influence is doubtful, but the fact, as the result of clinical observation, remains certain, that in some cases it is the primary and determining cause of loss of vision.

Mouth.—Wounds of the mouth are seldom met with, except as the result of gun-shot violence. The amount of injury done to the soft structures, however great, is usually only secondary to the mischief that

results to the brain, spinal cord, jaws, and skull, and must of course be treated on the ordinary principles of treatment of gun-shot and lacerated wounds.

TONGUE.—Wounds of the tongue usually occur from its tip or sides being caught between the teeth during an epileptic fit. They have been known to be inflicted by insane patients, in attempts to excise or to bite off this organ. Should the hæmorrhage be free, the application of a ligature, or even of the actual cautery, may be needed. These wounds generally assume a sloughy appearance for a few days; they then clean up, and granulate healthily. It is useless to bring the edges together by sutures, which readily cut out. If, however, a large portion of the tip be nearly detached, it must be supported in this way; but the threads should be thick and passed deeply. Pieces of tobacco-pipe are occasionally driven into and broken off in the substance of the tongue, and they either give rise to very free hæmorrhage, or the wound may close and heal over the foreign body, the existence of which may not be known to the patient. In a case of this kind, where a man complained of much pain and stiffness in the tongue, with difficulty in deglutition, I found, on examination, a hard swelling towards the base of the organ; and on cutting down upon this extracted three inches of the stem of a tobacco-pipe, which had been lodged there for several months.

THE PALATE and the PHARYNX are sometimes lacerated by gun-shot injuries of the mouth: or the wound may result from something that the patient happens to have between his lips being driven forcibly backwards into his mouth. Thus, a tobacco-pipe may, by a blow on the face, be driven deeply into the substance of the tongue, or perhaps into the pharynx, wounding and lodging behind the arches of the palate, breaking off short; the fragment that is left in giving rise to abscess, to ulceration of the vessels, and perhaps to fatal secondary hæmorrhage. In a case that was under my care some time ago, the soft palate was nearly detached from the palatal bones by a deep transverse wound, caused by the end of a spoon being forcibly driven into the mouth; good union took place eventually, the part having been stitched together by a few points of suture.

CHAPTER XXVII.

INJURIES OF THE THROAT: AND ASPHYXIA.

INJURIES OF THE LARYNX AND TRACHEA.

DISLOCATION AND FRACTURE OF THE LARYNX.—The cartilages of the larynx may be displaced, dislocated as it were, by violent blows; or they may be fractured by a squeeze, the rupture in some cases taking place transversely, in others longitudinally. Digital examination will at once detect the nature of the injury. In all these injuries there are pain and difficulty of breathing and of speech, and in some cases spitting of blood and cough, and there is danger of asphyxia, which indeed may be induced by simple concussion of the larynx. Should these symptoms be very urgent, tracheotomy may be required; if not, attention to position and support of the head will suffice.

WOUNDS OF THE THROAT.—These are of great frequency and import-

ance, implicating, as they do, some of the most important organs in the body. They may be divided into three categories:—

1. Those that do not extend into the Air- or Food-passages.

2. Those that implicate the Air-passage, with or without injury of the Œsophagus.

3. Those that are accompanied by injury of the Spinal Cord.

All these injuries are most commonly suicidal, and may be inflicted with every variety of cutting instrument; except where the spinal cord is injured, which must, in cases of suicide, be the result of gun-shot wound, and is necessarily fatal. Though incised, they are often jagged, and partake somewhat of the character of lacerated wounds, with great gaping of the edges.

1. **Wounds not extending into the Air- or Food-passages.**— In these wounds, there is very commonly free and even fatal hæmorrhage, and this sometimes though none of the larger arterial or venous trunks have been divided; the blood flowing abundantly from the venous plexuses or from the thyroid body when the wound is low down. If the larger arteries be touched, as the carotid and its primary branches, the hæmorrhage may be so abundant as to give rise to almost instantaneous death. Another source of danger in these cases proceeds from the admission of air into veins of the so-called "dangerous region" of the neck. For this a free wound is by no means necessary, as is instanced by a remarkable case that occurred some years ago near London, in which the introduction of a seton into the fore part of the neck was followed by death from this cause.

Wounds of the internal jugular vein are necessarily very dangerous. There is not only the ordinary risk of primary hæmorrhage from a vessel of such large size and directly communicating with the cerebral sinuses, but the special danger of the introduction of air into it; should these evils be safely got over, the secondary ones of recurrent hæmorrhage, diffuse inflammation, and pyæmia, may yet have to be encountered. The ligature of the vessel above and below the wound in it, exactly as if it were an artery that had been opened, is the only course than can be safely pursued. In one case in which this was being done, I saw and heard air enter the vein as it was being raised for the passage of the ligature, but the patient made a quick recovery.

The large nerves, such as the vagus and phrenic, can scarcely, in a suicidal wound, be divided without injury to the neighboring vessels, but they may be injured by stabs or gun-shot wounds. The division, however, of the respiratory nerves on one side only, or even of one of them, would in all probability be fatal in man, by interfering with the proper performance of the respiratory act. In a case with which I am acquainted, where the phrenic nerve was divided during ligature of the subclavian artery, death resulted in a few days from congestion of the lungs.

In the **Treatment** of wounds of the neck of this category, the principal points to be attended to are, in the first place, the arrest of hæmorrhage by the ligature of all bleeding vessels, whether arterial or venous; and, secondly, bringing together the lips of the wound. If the cut be longitudinal, this may be done by strips of plaster; if transverse by a few points of suture and by position, the head being fixed, with the chin almost touching the sternum, and retained in this posture by tapes passing from the nightcap to a piece of bandage fixed round the chest. I have had under my care one case in which, owing to the projection and mobility of the larynx, the wound did not unite, a large and deep gap

being left, which required a series of plastic operations in order to effect its closure.

2. **Wounds implicating the Air-passage.**—The air-passage is commonly wounded in suicidal attempts. It may be known to be opened by the air being heard and seen to bubble in and out of the wound during respiration. These wounds vary much in extent, from a small puncture with the point of a penknife to a cut extending completely across the throat, and even notching the vertebræ. They are frequently complicated with injuries of the larger vessels and nerves, and sometimes with wound of the œsophagus. Most commonly the cut is made high up in the neck; for the suicide, thinking that it is the opening into the air-passage that destroys life, draws the razor across that part of the throat where this is most prominent and easily reached; and thus, by not wounding the larger vessels, which are saved by the projection of the larynx, frequently fail in accomplishing his object.

These wounds occur in four situations: above the Hyoid Bone; in the Thyro-hyoid Space; through the Larynx; and through the Trachea.

The wound may be made **above the Hyoid Bone**; the cut extending into the mouth and wounding the root of the tongue. A wound in this situation is usually attended with much hemorrhage; and there is great trouble in feeding the patient, as the power of swallowing is completely lost.

The wound may be inflicted in the **Thyro-hyoid Space,** laying the pharynx open, but being altogether above the larynx. This is the most common situation for suicidal attempts. In many cases, the incision is carried so low as to shave off or partly to detach the epiglottis and the folds of mucous membrane around it. In other cases, the edges of the glottis or the arytænoid cartilages are injured, the cut extending back to the bodies of the vertebræ. Here also there are great difficulty in swallowing and great risk of the sudden supervention of œdema of the glottis, and consequent suffocation.

When the **Larynx** is wounded the incision is usually transverse; but I have seen a longitudinal cut made through the larynx, so as to split the thyroid and cricoid cartilages perpendicularly. In these cases of wounded larynx, there is much danger of the blood from the superficial parts trickling into the air-passage and asphyxiating the patient, and of inflammation of the bronchi and lungs supervening at a later period.

Wounds of the **Trachea** are not so common as those of the larynx, from which they differ but little in the attendant dangers.

The **Œsophagus** is seldom wounded, as it can only be reached through the trachea by a deep cut, which will probably implicate the large vessels.

Effects.—There are various sources of danger in wounds of the neck implicating the air-passage. The *hæmorrhage*, whether it proceed from any of the larger trunks, or consist of general oozing from a vascular surface, may either prove directly fatal by the amount of blood lost, or indirectly in consequence of the blood trickling into the air-tube, and, by accumulating in its smaller divisions, producing suffocation.

Asphyxia may supervene, either in the way already mentioned, or, when the wound has been inflicted above the larynx, from the occurrence of œdema of the glottis. It may likewise occur when the external opening is very small, and occasionally happens suddenly when the wound is nearly closed.

Another source of danger is the *loss of the natural sensibility of the glottis*, in consequence of which it no longer contracts on the applica-

tion of a stimulus. Hence food taken in by the mouth may pass into the larynx and appear at the external wound, even though neither the pharynx nor the œsophagus has been wounded. This I have observed in many cases of cut throat; hence the presence of food in the wound cannot in all cases be considered an evidence of injury to the food-passage. This occurrence is always a bad sign, and is never met with until a semi-asphyxial condition has come on, by which the nervous sensibilities are blunted, or until inflammation has been set up about the rima glottidis, giving rise to so much swelling as to interfere with the natural actions, and to deaden the perception of the part to the contact of a foreign body. In these cases also the sensibility of the air-passage generally is much lowered, so that mucus accumulates in the bronchi, even to a dangerous extent, the patient not feeling the necessity for expectoration, and often, indeed, having much difficulty in emptying his chest.

The occurrence of *bronchitis* and *pneumonia*, either from the inflammation extending downwards from the wound, or in consequence of the cold air entering the lungs directly, without being warmed by passing through the nasal cavities, is perhaps the most serious complication that can happen, and is a frequent cause of death in patients who survive the immediate effects of the wound.

The *depressed mental condition* of the patient also is usually unfavorable to recovery in all those instances in which the wound is suicidal, disposing him to the occurrence of low forms of inflammatory mischief.

Treatment.—The same general principles are required as in the management of those wounds of the throat that do not open up the mucous canals in this region. Hæmorrhage must be arrested by ligature of all the bleeding vessels, whether arteries or veins, so that no oozing or trickling into the wound may take place. In some cases the hæmorrhage consists principally of general venous oozing which cannot be stopped by ligature, the patient drawing a large quantity of blood into the air-passage through the wound. In these circumstances I have found it useful to introduce a large silver tube into the aperture in the windpipe, and to plug the wound around it. So soon as the bleeeding has fairly ceased, the plugs and the tube must be removed.

The edges must next be brought together by a few stitches introduced at the sides, and by attention to position, the head being fixed by tapes as described at p. 596. I think, with Liston, that in these cases the wound should never be closely sewed up, nor stitches introduced into the centre of the cut. If the centre of the integuments be closely drawn together, coagula may accumulate behind them, in the deeper parts of the wound, so as to occasion a risk of suffocation; and, as the wound must eventually close by granulation, no material advantage can possibly be gained by this practice. There is an exception, however, to this rule of not using stitches in the central part of the wound in cut throat. In cases in which the trachea has been completely cut across, a stitch or two on each side of the tube is necessary, in order to prevent the wide separation of the two portions that would otherwise take place, owing to the great mobility of the larynx and upper end of the windpipe.

In order to lessen the liability to inflammation of the lungs, the patient should be put into a room, the temperature of which is raised to about 80° Fahr., with a piece of lightly folded muslin acting as a respirator laid over the wound. So soon as the cut surfaces begin to granulate,

water-dressing may be applied, and the edge of the wound brought into apposition by strips of plaster, and a compress if necessary. During the treatment, the principal danger proceeds from inflammatory affections of the chest; these must accordingly be counteracted by the temperature in which the patient is placed, and by the adoption of antiphlogistic measures. It must, however, be remembered that the mental depression, and the bodily exhaustion from loss of blood, that are common in these cases, do not allow very active treatment.

The **administration of food** in these cases always requires much attention. As a general rule, the patient should be kept on a nourishing diet, with a moderate allowance of stimulants. If, as not uncommonly happens, the food-passage be opened in consequence of the wound extending into the mouth, the pharynx, or the œsophagus, it is of course impossible for the patient to swallow, and the administration of nourishment becomes very difficult. This is best accomplished by means of an elastic gum catheter passed through the mouth into the gullet or stomach. This is easier than passing the instrument through the nose, and much better than introducing it through the wound. In this way a pint or more of the strongest beef-tea or soup, with Liebig's "Extract of Meat," mixed with two or three eggs, and having an ounce or two of brandy added to it, should be injected regularly night and morning, until the patient is able to swallow. In those cases in which the wound is above the larynx, there is occasional danger of the supervention of œdema of the glottis; should this occur, tracheotomy may be necessary to prolong the patient's life.

As consequences of wounds of the throat, we occasionally find stricture of the trachea, or aërial fistula. If the vocal cords have been injured, loss of voice may follow.

Aërial Fistula may sometimes form, owing to the skin doubling in and becoming adherent to the edges of the wound in the air-tube, and most frequently occurs when the cut is in the thyro-hyoid space; adhesion taking place between the inverted integuments and the os hyoides above, and the surface of the thyroid cartilage below. The same may occur in the crico-thyroid space, and indeed at any part of the larynx that has been opened. When this happens, there is a tendency to the fistula continuing patent. In these circumstances, I have found the following operation successful.

The edges of the fistulous opening having been freely pared, and the knife passed under them for some distance so as to detach them from the subjacent parts, a vertical incision is made through the lower lip of the opening, so as to split it downwards. Two points of suture are then inserted into each side of the horizontal incisions, bringing their edges into contact, *but the vertical cut is left free* for discharges and mucus to drain through, and for the expired air to escape, lest emphysema occur. Unless this outlet be afforded, these fluids will burst through the sutures, and thus destroy union of the edges.

It is not in every case that an aërial fistula can be safely closed. In some instances the larynx becomes contracted either by drawing in of the wound, or by thickening of the mucous membrane above the artificial opening to such an extent that the fistula becomes essential, in addition to the orifice of the glottis, for the purposes of respiration. In such circumstances, any attempt at closing it will be attended or followed by symptoms of impending asphyxia or collapse of the lungs; and it may be necessary to leave the opening free, or even, as happened in a case under my care, in which an opening was left in the crico-thyroid

membrane of a girl who had attempted suicide by cutting her throat, to enlarge the opening and to introduce a silver tube in order to relieve the breathing from the effects of the laryngeal constriction.

Foreign Bodies in the Air-Passage.—A great variety of substances have been found in the air-passage: such as nut-shells, beans, cherry-stones, teeth, meat, money, buttons, pins, fish-bones, bullets, pills, pebbles, and pieces of stick. These foreign bodies are not introduced into the air-passage by any effort of deglutition, for no substance can be *swallowed* through the glottis; but they are *inhaled*; thus, if a person, whilst holding anything in his mouth, make a sudden inspiration, the current of air may draw it between the dilated lips of the glottis into the larynx.

The symptoms vary, according to the situation in which the foreign body is lodged, its nature, and the period that elapsed since the occurrence of the accident. The foreign body may lodge in one of the ventricles of the larynx; or, if light, it may float in the trachea, carried up and down by the movement of the air in expiration and inspiration. If too heavy for this, it will fall into one or other of the primary divisions of the trachea, and, as Aston Key has observed, will most commonly be found in the right bronchus. The explanation of this has been pointed out by Gray, who states that on making a transverse section of the trachea, and taking a bird's-eye view of the bifurcation, the septum will be seen to be considerably to the left of the middle line; so that any foreign body falling down the trachea would naturally have a greater chance of entering the right than the left bronchus, although the left bronchus is a more direct continuation of the trachea than the right. The greater size of the right bronchus would also favor the entrance of a foreign body into it. If the substance be small, it may pass into one of the secondary divisions of the bronchi; and, if it continue to be lodged here for a sufficient length of time, may make a kind of cavity for itself in the substance of the lung, where it may either lie in an abscess, or become encysted.

The *Symptoms* may be divided into three stages: 1. Obstruction, immediately following the introduction of the substance; 2. Irritation, produced by its presence; and 3. Inflammation, coming on at a later period.

1. **Symptoms of Obstruction.**—The immediate symptoms vary somewhat according to the size and nature of the body, and the part of the air-tube that it reaches. In all cases there is a feeling of intense suffocation, with great difficulty of breathing, and violent fits of spasmodic coughing, often attended by vomiting; during which the foreign body may be expelled. Indeed, its partial entry and immediate extrusion by coughing are not uncommon. In some cases, immediate death may ensue at this period. If the body have entered the air-passage fully, there is violent coughing, with feeling of suffocation for an hour or two, accompanied by lividity of the face, great anxiety, and sense of impending death. There is also usually pain about the episternal notch. The symptoms then gradually subside, but any movement on the part of the patient brings them on again with renewed violence. All these symptoms are most severe if the foreign body remain in the larynx; the voice being then croupy, irregular in tone, or altogether lost. If it be lodged elsewhere, so often as it is coughed up, and strikes against the interior of the larynx, an intease feeling of suffocation is produced; and if it happen to become impacted there, sudden death may result, even though it be not of sufficient size to block up the air-passage, apparently by the spasm

that is induced. Some years ago a boy died at the Westminster Hospital before tracheotomy could be performed, in consequence of a flat piece of walnut-shell that had entered the trachea being suddenly coughed up, and becoming impacted in one of the ventricles of the larynx. The symptoms, during this period, are much less severe than when the foreign body is in the trachea or bronchi.

When there is a suspicion that the foreign body is lodged in the larynx, a laryngoscopic examination should be made, when it may, perhaps, if large—as a plate with false teeth—be seen between the vocal cords.

2. **Symptoms of Irritation.**—When the foreign body has passed into the air passage, and the immediate effects produced by its introduction have passed over, another set of symptoms, dependent on the irritation produced by it, is met with; and it is during the occurrence of these that the patient is most generally brought under the Surgeon's observations. These symptoms are of two kinds: *general* and *auscultatory.*

The **General Symptoms** consist of occasional fits of spasmodic cough accompanied by much difficulty of breathing, a feeling of suffocation, and an appearance of urgent distress in the countenance. These attacks do not occur when the patient is tranquil, but come on whenever the foreign body is coughed up so as to strike the larynx, and the upper and more sensitive parts of the air passage. As a general rule, the distress is less, the lower the substance is lodged; the sensibility of the lower portion of the trachea and that of the bronchi being much less acute than that of the larynx and of the upper part of the trachea. In consequence of the irritation, there is usually abundant expectoration of frothy mucus. These symptoms often remit for a time, more particularly if the foreign body become fixed. In some cases, indeed, there appears to be so little distress some days after the accident, that considerable doubt may exist whether any foreign body really be lodged in the air-passage or in the lungs; and much valuable time is often lost by the indisposition of the surgeons to adopt active measures.

The **Auscultatory Signs** depend necessarily upon the situation of the foreign body. If this be loose and floating, it may be heard, on applying the ear to the chest, moving up and down, and occasionally striking against the sides of the trachea. If it be fixed, it will necessarily give rise to a certain degree of obstruction to the admission of the air beyond it, perhaps occasioning *bruits* during its passage. If it be impacted in the larynx, the voice will be hoarse and croupy, and there will be a loud rough sound in respiration, with much spasmodic cough and distress in breathing. If it be impacted in one bronchus, the respiratory murmur will be much diminished, or even absent, in the corresponding lung, and probably puerile in the other; whilst percussion will yield an equally clear and sonorous sound on both sides of the chest, air being contained in the lung of the obstructed side, but not readily passing in and out. If one of the subdivisions of either bronchus be occupied by the foreign body the entrance of air will be prevented in the corresponding lobe of that lung, though it enter freely every other part of the chest. If the foreign body be annular, or perforated, peculiar sibilant and whistling noises may be heard as the air passes over and through it.

3. **Inflammation.**—After a foreign body has been lodged for a day or two, *inflammation of the bronchi or lungs* is apt to be set up, in some cases, however, this only occurs after a considerable time has elapsed, or, perhaps, not at all, much depending, of course, on the shape and

character of the irritant. If it continues to lodge, it generally forms for itself a cavity in the substance of the lung, whence purulent and bloody matters are continually expectorated, until the patient dies of phthisis in the course of a few months, or a year or two. Occasionally, however, the substance has been coughed up after a very long lodgment, the patient recovering. Thus, Tulpius relates a case in which a nut-shell was coughed up after being lodged for seven years; and Heckster one in which a ducat was thus brought up after a lapse of two years and a half; the patients, in both instances, recovering. In other cases death may ensue, although the foreign body is coughed up; thus Sue relates an instance in which a pigeon-bone was spat up seventeen years after its introduction, the patient, however, dying in a little more than a year from marasmus.

Prognosis.—This depends more upon the nature of the foreign body and its size than on any other circumstance. If it be rough, angular, and hard, there is necessarily much more risk than if it be soluble in, or capable of disintegration by, the mucus of the air-passage. So long as the foreign body is allowed to remain, the patient is in imminent danger, either from immediate and sudden suffocation, or from inflammation at a more remote period.

The danger depends greatly upon the length of time during which the body is allowed to lodge. Of 62 cases which I collected in 1850 (4 of which had fallen under my own observation), I found the time that the foreign body was allowed to remain in, and the result of the case, stated in 49 instances.

Period of Retention.	Number of Cases.	Recovered.	Died.
Less than 24 hours	8	6	2
Between 24 and 48 hours	4	3	1
Between 48 hours and 1 week . . .	13	6	7
Between 1 week and 1 month . . .	8	4	4
Between 1 month and 3 months . . .	3	3	0
Between 3 months and 1 year . . .	6	4	2
More than 1 year	7	4	3
Total	49	30	19

From this it would appear that, if the patient escaped the danger of the immediate introduction, the greatest risk occurred between the second day and the end of the first month, no fewer than 11 patients out of 21 dying during this period; and then that the mortality diminished until the third month, from which time it increased again.

The cause of death also varies according to the period at which the fatal result takes place. During the first twenty-four, and, indeed, forty-eight hours, it happens from convulsions and sudden asphyxia. During the first few weeks it is apt to occur from inflammatory mischief within the chest; and after some months the patient will be carried off by marasmus or phthisis.

Spontaneous expulsion of the foreign body usually by a violent fit of coughing, occasionally occurs. Gross of Philadelphia finds that there are 49 cases on record, in which the body was spontaneously expelled, the patient recovering. Of these, in 37 it was expelled during a fit of coughing. The period during which a foreign substance may remain in the air-passage before it is spontaneously expelled, varies from a few minutes to many months or years; in one case, a piece of bone introduced at the age of three, was not ejected until sixty years had elapsed. In eight cases, death followed the spontaneous expulsion.

Treatment.—This accident is always very serious, and hence requires prompt and energetic means to be used in order to save the patient; and fortunately the means at our disposal, consisting of the simple operation of opening the trachea, and thus facilitating the expulsion of the foreign body, are usually highly successful. Of 60 cases in which the result was noted, I found that 37 lived, and 23 died; but on analysing these cases more closely, it appeared that in 39 no operation was performed; the expulsion of the foreign body being effected by the efforts of nature. Of these 23 died, and 16 lived. In the remaining 21 cases, tabulated below, tracheotomy was performed; of these 18 lived, and only three died, showing a remarkable success attendant on this operation.

Period of Retention	Number of Cases.	Cured.	Died.
Less than 24 hours	3	2	1
Between 24 and 48 hours	2	2	0
Between 48 hours and 1 week	9	8	1
Between 1 week and 1 month	5	4	1
Between 1 and 3 months	2	2	0
Total	21	18	3

Gross has also given extensive statistics of the removal of foreign bodies, and has found that out of 68 recorded cases in which *tracheotomy* has been performed, the operation was successful in 60, and in eight the patient died. In some cases *laryngotomy* has been performed instead of tracheotomy; and the foreign body has been equally well expelled. Gross gives thirteen instances of this, successful in their results, and four in which death followed the operation. *Laryngo-tracheotomy* was done in thirteen cases; of these there were ten recoveries and three deaths.

Gross' statistics of 160 cases are as follows:

	Recovered.	Died.	Total.
Spontaneous Expulsion	49	8	57
Inversion of the Body alone	5	0	5
Tracheotomy	60	8	68
Laryngotomy	13	4	17
Laryngo-tracheotomy	10	3	13

Emetics, sternutatories, and succussion of the body, are all either useless or dangerous. Inversion of the body has succeeded in several instances, and might, I think, be tried before operation is had recourse to, more particularly if the foreign body be a coin, and be movable in the air-passage. Padley caused the ejection of a sixpenny-piece in this way from the trachea of a man, and he recommends the supine as a safer and better position than the prone. There is undoubtedly danger in inversion, of the supervention of laryngeal spasm, but statistics do not prove that any fatal consequences have resulted from this cause. Should, however, the attempt at expulsion by inversion of the body bring on an attack of laryngeal spasm the attempt should be abandoned, as not only useless but in the highest degree dangerous. When the foreign body is lodged in the upper part of the air-passage, it can sometimes be detected by laryngoscopic examination, and may be removed by forceps, or such other means as the ingenuity of the Surgeon may suggest. Thus, in a case recorded by Petrie of Liverpool, a penny was successfully removed by forceps after having been impacted six years in the larynx of a boy; and, in another case, in the Liverpool Northern Hospital, a piece of bone lying over one of the vocal cords was detected by the laryngoscope, and removed by means of long and sharply curved forceps.

If, then, a patient be seen a few hours, days, or weeks, after a foreign body has been introduced into the air-passage, an examination with the laryngoscope may be made; and if the body be within reach, an attempt may be made to remove it by the mouth. If it be not in sight, inversion of the body may be practised; and if both these means fail, or be inapplicable, tracheotomy ought to be performed. And this should be done even though the symptoms be not urgent. There is often a remission in the symptoms, a period of deceptive security, by which the Surgeon must not be put off his guard. But, it may be asked, for what purpose is the trachea opened? Why should not the foreign body be expelled through the same aperture by which it has entered? The opening in the trachea performs a double purpose; it not only serves as a ready and passive outlet for the expulsion of the foreign body, but also as a second breathing aperture in the event of its escaping through the glottis. The advantage of the opening in the trachea as a ready aperture of expulsion is evident from the fact that, of 14 of the operated cases in which it is stated how the foreign body was expelled, I find that in 12 it was ejected through the artificial opening, whilst in 2 only did it pass out through the glottis.

The reason why the foreign body usually passes out of the artificial opening in preference to escaping by the glottis is, that the sides of the former aperture are passive, whereas those of the latter are highly sensitive and contractile. Before the operation is performed, it will be found that the great obstacle to expulsion is not only the sensitiveness of the larynx, great irritation being induced when it is touched from within, but also the contraction of the glottis, by the closure of which not only is the expulsion of the foreign body prevented, but respiration is impeded. Every time the foreign body is coughed up so as to touch the interior of the larynx, intense dyspnœa is produced, owing to sudden and involuntary closure of the glottis, by which respiration is entirely prevented and suffocation threatened; the expulsion of the body is consequently arrested, unless it by chance take the glottis by surprise, and pass through it at once in the same way that it has entered it without touching its sides. If there be a second breathing aperture, though the larynx is equally irritated by the foreign body, yet this dyspnœa cannot occur, respiration being carried on uninterruptedly by one opening whilst the foreign body escapes through the other; and thus, in these circumstances, it may pass through the glottis with but little inconvenience.

In some cases, the foreign body is expelled at once after the trachea has been opened; in others, not until some hours, days, or even weeks, have elapsed. Thus, in Houston's case, a piece of stick was not coughed up until ninety-seven days after the operation; and in Brodie's case, sixteen days elapsed before the half-sovereign came away.

The expulsion has in some instances been facilitated by inverting the patient, shaking him, or striking him on the back. In cases in which the foreign body is not readily expelled, it has been proposed to introduce forceps through the wound in the trachea and extract it. But, although in some instances this has succeeded, as in a case in which Walters, of Reigate, removed a trachea-tube that had accidentally slipped five inches into the air-passage, the uncertainty and danger of such a proceeding are so great that few Surgeons will be disposed to attempt it; the introduction of the forceps producing violent irritating cough, during which their points might readily be driven through the bronchi, and thus wound the lung or contiguous important structures. Besides this, there would be the danger of seizing the projecting angle at the

bifurcation of the bronchi instead of the foreign body, and thus injuring the parts seriously. If the foreign body be fixed, the safer plan will certainly be to leave the aperture in the trachea unclosed, and wait for the loosening of the body and its ultimate expulsion, which have hitherto occurred in all cases that have been operated on; or its escape might be facilitated by the gentle introduction of a probe, so as to dislodge it if seated in either bronchus, though this should be done with great caution; or the patient may be inverted and succussed, when the expulsion may take place. Should it not then escape, the wound should be kept open by means of blunt hooks, when, perhaps, it may be ejected.

Antiphlogistic treatment must be continued during the whole progress of the case. After the escape of the foreign body, the opening in the trachea must be closed.

Scalds of the Mouth, the Pharynx, and the Glottis, occasionally occur from attempts to swallow boiling water; or these parts are scorched by the inhalation of hot air or flame. The scalding chiefly happens to the children of the poor, who, being in the habit of drinking cold water from the spout of a kettle, inadvertently attempt to take a draught from the same source when the water is boiling. The hot liquid is not swallowed, but, though immediately ejected, has scalded the inside of the mouth and pharynx, giving rise to much inflammation, which, extending to the glottis, may produce œdema of it, and thus speedily destroy life by suffocation In three cases which I examined after death, there was no sign of inflammation below the glottis, though the lips of this aperture were greatly swollen; and this I believe to be invariably the case, the inflammation not extending into the interior of the larynx, as was pointed out by Marshall Hall. The accident always reveals itself by very evident signs; the interior of the mouth looks white and scalded, the child complains of great pain, and difficulty of breathing soon sets in; which, unless efficiently relieved, may terminate in speedy suffocation. In those cases in which these parts have been similarly injured by the flame produced by the explosion of gas or of fire-damp being sucked into the mouth, the same conditions present themselves.

In the **Treatment** of this injury, the main point to attend to is to subdue the inflammation before it involves the glottis to a dangerous extent. With this view, leeches should be freely applied to the neck, and calomel with antimony administered. If symptoms of urgent dyspnœa have set in, tracheotomy must be performed without delay; and, if the child be not too young, a tube must be introduced into the aperture so made, and kept there until the swelling about the glottis has been subdued by a continuance of the antiphlogistic treatment. In the majority of the cases, however, that have fallen under my observation, in which this operation has been performed, the issue has been a fatal one, from the speedy supervention of broncho-pneumonia; but as it affords the only chance of life when the dyspnœa is urgent, it must be done, though its performance in very young children is often attended by much difficulty, from the shortness of the neck and the small size of the trachea.

ASPHYXIA OR APNŒA.

Asphyxia, or, as it is more correctly termed, Apnœa, may arise from various causes. The following classification is derived from a table by Harley.

1. **Mechanical Impediment to the Entrance of Air into the Lungs.** A. **From Accident**; either (1) *external*, as in pressure on

the trunk preventing expansion of the chest; pressure on the throat; smothering; injury of the spinal cord causing paralysis of the respiratory muscles; penetrating wound of the chest, admitting air; or (2) *internal*, as in obstruction of the fauces or larynx by foreign bodies, or in constriction of these parts from the application of irritating fluids. B. From **Disease**; as in pressure on the trachea by an aneurism or other tumor; œdema of the glottis; obstruction of the air-passage by tumor; accumulated mucus, &c.

2. **Drowning.**

3. **Absence of Oxygen,**—nitrogen, hydrogen, or some other harmless gas being inhaled.

4. **Accumulation of Carbonic Acid Gas in the Blood.**

5. **Inhalation of Toxic Gas or Vapor.**

Several of the conditions above enumerated as producing apnœa have been already described in the preceding pages; and others will be considered when we speak of diseases of and operations on the Air-passage. In this place we will speak of the Surgical management of cases in which respiration has been suspended by Drowning, Hanging, and the respiration of Noxious Gases.

The general subject of Suspended Animation from these various causes cannot be discussed here, but we must briefly consider some points of practical importance in its treatment.

In cases of **Drowning**, life is often recoverable, although the sufferer may have been in the water for a considerable time; for, though *immersed*, he may very probably not have been *submersed* during the whole time. The period after which life ceases to be recoverable in cases of submersion, cannot be very accurately estimated. The officers of the Royal Humane Society, who have great experience, state that most generally persons are not recoverable who have been more than four or five minutes under water. In these cases, however, although submersion may not continue for a longer period than this, the process of asphyxia does; this condition not ceasing on the withdrawal of the body from the water, but continuing until the blood in the pulmonary vessels is aërated, either by the spontaneous or artificial inflation of the lungs. As several minutes are most commonly consumed in withdrawing the body from the water and conveying it to land, during which time no means can be taken to introduce air into the lungs, we must regard the asphyxia as continuing during the whole of this period; occupying, indeed, the time that intervenes between the last inspiration before complete submersion, and the first inspiration, whether artificial or spontaneous, after the removal of the body from the water. The latest time at which life can be recalled, during this period, is the measure of the duration of life in asphyxia. If, during this period, the action of the heart should cease entirely, I believe, with Brodie, that the circulation can never be restored. But although we may put out of consideration those marvellous cases of restoration of life that are recorded by the older writers, and which are evidently unworthy of credence, are we to reject as exaggerated and apocryphal cases such as that by Smethurst, in which recovery took place after ten minutes' submersion; that by Douglas of Havre, in which the patient was not only submerged, but had actually sunk into, and was fixed in the mud at the bottom of the harbor for from twelve to fourteen minutes; or that by Weeks, in which the submersion, on the testimony of the most credible witnesses, exceeded half an hour? I think that it would be unphilosophical in the extreme to deny the facts clearly stated by these gentlemen; the more so that in these, as in many other

instances of apparent death from drowning, life appears to have been prolonged by the patient falling into a state of syncope at the moment of immersion. We must therefore not despair of recovery, but should employ means of resuscitation, even though the body have been actually under water a considerable time.

There are certain minor means often employed in the case of persons who have been immersed in water, and are apparently drowned, which appear to be well adapted for the treatment of the less severe forms of asphyxia, or rather cases of syncope from fright and immersion in cold water. These consist, after the nose and mouth have been cleared of any collections of mucus, in the application of heat by means of a bath at about the temperature of 100° Fahr. until the natural warmth is restored; in the employment of brisk friction; and in passing of ammonia to and fro under the nostrils. It is evident that these measures can have no direct influence upon the heart and lungs, but can only act as general stimuli to the system, equalising the circulation if it be still going on; and, by determining the flow of blood to the surface, tending to remove those congestions that are not so much the consequences of the asphyxia, as of the sojourn of the body for several minutes in cold water; they would therefore be of especial service during the colder seasons of the year. A hot bath may also, by the shock it gives, excite the reflex respiratory movements. With the view of doing this with a greater degree of certainty, cold water should be sprinkled or dashed upon the face at the time when the body is immersed in the hot bath, as in this way a most powerful exciting influence can be communicated to the respiratory muscles; and the first object of treatment in all cases of asphyxia—the re-establishment of respiration—would more rapidly and effectually be accomplished; deep gaspings ensuing, by which the air would be sucked into the remote ramifications of the air-cells, aërating the blood that had accumulated in the pulmonary vessels, and enabling it to find its way to the left cavities of the heart, and thus to excite that organ to increased activity. These means, then, are useful in those cases of asphyxia in which the sufferer has been but a short time submerged, and in which the heart is still acting, and the respiratory movements have either begun of their own accord on the patient being removed from the water, or in which they are capable of being excited by the shock of a hot bath, aided by the dashing of cold water in the face. At the same time the lungs may be filled with pure air, by compressing the chest and abdomen, so as to expel the vitiated air, and then allowing them to recover their usual dimensions by the natural resiliency of their parietes. A small quantity of air will, in this way, be sucked in each time the chest is allowed to expand, and thus the re-establishment of the natural process of respiration may be much hastened. This simple mode of restoring the vital actions should never be omitted, as it is not attended with the least danger, and does not in any way interfere with the other measures employed. Marshall Hall has recommended that the patient be turned prone, so that the tongue may hang forwards, and the larynx thus be opened; and that respiration be then set up by gentle pressure along the back, and by turning the patient on his side at regular intervals. If, by these means, we succeed in restoring the proper action of the respiratory movements, it will merely be necessary to pay attention to the after-treatment. Should we, however, fail in restoring respiration, we should have recourse to other and more active measures.

In the more severe cases of asphyxia, warmth should be applied by means of a hot-air bath, by which not only the natural temperature of

the body may be re-established, but the blood in the capillaries of the surface be decarbonised. The most direct and efficient means, however, that we possess for the re-establishment of the circulation in these cases is certainly **Artificial Respiration.** In this way alone the pulmonary artery and the capillaries of the lungs can be unloaded of the blood that has stagnated in them, and the left side and substance of the heart will be directly and rapidly supplied with red blood. The whole value of artificial respiration depends, however, upon the way in which it is employed. Inflation is not very effectual from the mouth of an assistant into the nostrils or mouth of the sufferer, as air once respired is not well fitted for the resuscitation of the few sparks of life that may be left, but it is in many instances the readiest and indeed the only mode by which respiration can be set up, especially if water or other fluids have found their way into the mouth.

The bellows, if properly constructed for artificial inflation, so that the quantity of air injected may be measured, are no doubt very useful; and if furnished with Leroy's trachea-pipes, or what is better, with nostril tubes, may be safely employed. About fifteen cubic inches of air may be introduced at each stroke of the bellows, and these should be worked ten or a dozen times in a minute. The lungs should be emptied by compression of the chest before beginning to inflate, and, after each inflation, by compressing the chest and abdomen; but care must also be taken not to employ much force, lest the air-cells be ruptured. Richardson has devised a pocket-bellows for artificial respiration, consisting of two elastic hand-bellows with a single tube for introduction into the nostril. A safe, and at the same time a very efficient mode of introducing pure air into the lungs, is, by the elastic expansion of the walls of the chest. This may be effected in various ways; either by means of the split sheet, as recommended by Leroy and Dalrymple (Fig. 258), or else

Fig. 258.—Split-sheet applied.

by alternately compressing the chest and abdomen with the hand, and then removing the pressure so as to allow the thorax to expand by the natural resiliency of its parietes, and thus, each time it expands, to allow a certain quantity of air to be sucked into the bronchi. The

method recommended by Silvester, and now adopted by the Royal Humane Society, effects this purpose with great ease and certainty. It is carried out in the following way. The patient is laid on a flat surface on his back with his head and shoulders slightly raised on a pillow. The tongue should be drawn and held forwards. The arms are then to be grasped just above the elbows, and to be drawn gently and steadily upwards above the head (Fig. 259), in which position they are kept for

Fig. 259.—Silvester's Method—Inspiration.

two seconds; they are then to be turned downwards, and to be pressed for two seconds gently and firmly against the sides of the chest (Fig. 260). These movements are to be repeated deliberately about fifteen

Fig. 260.—Silvester's Method—Expiration.

times in the minute, until natural efforts at respiration are induced, when they are to be discontinued, and the ordinary means to promote circulation and warmth employed. The quantity of air introduced need

not be large; for, by the law of the diffusion of gases, if fresh air be only introduced into the larger divisions of the bronchi, it will rapidly and with certainty find its way into the ultimate ramifications of these tubes. This last means of inflation has the additional advantage of resembling closely the natural process of respiration, which is one of expansion from without inwards, and not, as when the mouth or bellows are used, of pressure from within outwards. In one case the lungs are, as it were, drawn outwards, the air merely rushing in to fill up the vacuum that would otherwise be produced within the thorax by the expansion of its parietes; in the other they are forcibly pressed up from within, and hence there is a danger of rupture of the air-cells.

Inflation of the Lungs with Oxygen Gas is likely to be of great service in extreme cases of asphyxia. I have found by experiment that the contraction of the heart can be excited by inflating the lungs with this gas, when the introduction of atmospheric air fails in doing so; and there are cases on record in which resuscitation was effected by inflating the lungs with oxygen, when in all probability it could not have been effected with any other means. In my Essay on "Asphyxia" will be found a case of resuscitation, in which oxygen was successfully administered by Weeks after the asphyxia had continued three-quarters of an hour.

Whatever means of resuscitation are adopted, they should be continued for at least three or four hours, even though no signs of life show themselves; and after ordinary respiration has been re-established, the patient should be kept quiet in bed for some hours.

The danger of the supervention of **Secondary Asphyxia** after recovery has apparently taken place is much increased, and indeed is usually brought about, by some effort on the part of the patient that tends to embarrass the partially restored action of the heart and lungs. The patient, being to all appearances resuscitated, is allowed to get up and walk home, when the symptoms of asphyxia speedily return. Should symptoms of secondary asphyxia, such as stupor, laborious respiration, dilatation of the pupils, and convulsions, manifest themselves, artificial respiration should be immediately set up, and be maintained until the action of the heart has been fully restored. In these cases I should, from the very great efficacy of electricity, in the somewhat similar condition resulting from the administration of the narcotic poisons, be disposed to recommend slight shocks to be passed through the base of the brain and upper portion of the spinal cord, so as to stimulate the respiratory tracts.

Asphyxia from the **Respiration of the Noxious Gases**, such as carbonic acid, is best treated by exposing the surface of the body to cold air, by dashing cold water upon the face, and by setting up artificial respiration without delay, if the impression of cold upon the surface do not excite these actions. There is a peculiar variety of this kind of asphyxia, which is occasionally met with among infants, the true nature of which was pointed out to me by Wakley, who, as coroner, had abundant opportunities of witnessing it, as it is not an uncommon cause of accidental death amongst the children of the poor. It is that condition in which a child is said to have been *overlaid;* the child, sleeping with its mother or nurse, being found in the morning suffocated in the bed. On examination no marks of pressure will be found; but the right cavities of the heart and lungs are gorged with blood, and the surface is livid, clearly indicating death by asphyxia. That this accident is not the result of the mother overlaying her child, is not only evident from the

post-mortem appearances, but was clearly proved by a melancholy case to which I was called several years ago, in which a mother, on waking in the morning found her twin infants lying dead, one on each side of her. Here it was evident, from the position of the bodies, that she could not have overlaid both. The true cause of death is partly the inhalation of, and slow suffocation by, the vitiated air which accumulates under the bed-clothes that have been drawn, for the sake of warmth, over the child's head, and partly the diminished supply of oxygen. In such cases, resuscitation by artificial respiration should always be attempted if any signs of life be left.

Asphyxia from the respiration of **Carbonic oxide** is more frequent than Surgeons are apt to imagine. As has been already stated in the chapter on Burns, death often takes place in cases where buildings are on fire from poisoning by the respiration of carbonic oxide. According to Leblanc, it is this gas that is the poisonous agent given off in the fumes of charcoal. The effect of the respiration of carbonic oxide gas is to deprive the red corpuscles of their power to carry oxygen, and death takes place rather from the want of oxygen than from the poisonous action of carbonic oxide itself.

The inhalation of oxygen is of service in such cases, but it must be borne in mind that death is generally very rapid.

In cases of **Hanging**, death seldom results from pure asphyxia, but is usually the consequence, to a certain degree at least, of apoplexy, and commonly of simultaneous injury of the spinal cord. In these cases, bleeding from the jugular vein may be conjoined with artificial respiration.

If there should be a difficulty in setting up artificial respiration through the mouth or nose, as is more especially likely to happen when the patient has been suffocated by breathing noxious gases, or in cases of hanging, tracheotomy or laryngotomy should at once be performed, and the lungs inflated through the opening thus made in the neck.

INJURIES OF THE PHARYNX AND ŒSOPHAGUS.

Wounds of the Œsophagus are chiefly met with in cases of cut throat, in which, as has been already stated in treating of this injury, they occasion much difficulty by interfering with deglutition.

Foreign Bodies not uncommonly become impacted in the pharynx and œsophagus, and may produce great inconvenience by their size or shape. If large, as a piece of money, or a lump of meat, the substance may become fixed in the lower part of the pharynx or the commencement of the œsophagus, which is narrowed by the projection of the larynx backwards, and, compressing or occluding the orifice of the glottis, may suffocate the patient at once. If the foreign body go beyond this point, it usually becomes arrested near the termination of the œsophagus. When it is small or pointed, as a fish-bone, pin, or bristle, it may become entangled in the folds of mucous membrane that stretch from the root of the tongue to the epiglottis, or that lie along the sides of the pharynx. In some cases it may even perforate these, penetrating the substance of the larynx, and thus producing intense local irritation, cough, dyspnœa, and suffocation. The foreign body, by transfixing the coats of the œsophagus, may seriously injure some neighboring parts of importance. Thus, in a curious case admitted into the University College Hospital, a juggler, in attempting to swallow a blunted sword, by pushing it down his throat, perforated the œsophagus and wounded the pericardium; death consequently resulted in the course of a few days.

The **Symptoms** occasioned by the impaction of a foreign body in the food-passages are sufficiently evident. The sensations of the patient, who usually complains of uneasiness about the top of the sternum, difficulty in swallowing solids, and perhaps an urgent sense of suffocation, lead to the detection of the accident. Should any doubt exist, the Surgeon may, by introducing his finger, explore nearly the whole of the pharynx, and should examine the œsophagus by the cautious introduction of a well-oiled probang.

If the impaction be allowed to continue unrelieved, not only may deglutition and respiration be seriously interfered with, but ulceration of the œsophagus will take place, and abscess form either behind it or between it and the trachea; or fatal hæmorrhage may ensue by perforation or ulceration of neighboring blood-vessels.

The **Treatment** must depend upon the nature of the foreign body and its situation. Should it be large, blocking up the pharynx so as to render respiration impracticable, it may be hooked out by the Surgeon's fingers. Should asphyxia have been induced, it may be necessary to perform tracheotomy at once, and to keep up artificial respiration until the foreign body can be extracted. If it be small or pointed, as a fish-bone or pin for instance, though it have lodged high up, the Surgeon will usually experience great difficulty in its removal, as it becomes entangled between and is covered in by the folds of the mucous membrane, where from its small size it may escape detection. In these cases an expanding probang will be found useful. After it has been removed, the patient will experience for some time a pricking sensation, as if it were still fixed. If the impacted body have passed low down into the œsophagus, the Surgeon must deal with it according to its nature. If it be smooth and soft, as a piece of meat for instance, it may be pushed down into the throat by the gentle pressure of the probang. If, however, it be rough, hard, or sharp-pointed, as a piece of earthenware, or bone, or a metallic plate, with false teeth attached, such a procedure would certainly cause perforation of the œsophagus, and serious mischief to the parts around; in these circumstances, therefore, an attempt at extraction should be made by means of long slightly curved forceps, constructed for the purpose.

The foreign body occasionally becomes so firmly impacted in the pharynx or œsophagus, that the employment of any degree of force for extracting it would be attended with danger of perforating the œsophagus or transfixing the large vessels of the neck; in these circumstances it may become necessary to open the tube and thus remove it. The operation of **Pharyngotomy** or **Œsophagotomy** is seldom called for; if required, it may be performed by making an incision about four inches in length along the anterior border of the left sterno-mastoid muscle, the œsophagus naturally curving somewhat towards the left side. The dissection must then be carried with great caution between the carotid sheath and the larynx and trachea in a direction backwards, the omo-hyoid muscle having been divided in order to afford room. Care must be taken in this deep dissection not to wound either of the thyroid arteries, more especially the inferior one, which will be endangered by carrying the incisions too low. When the pharynx or the œsophagus has been reached, a sound or catheter should be passed through the mouth into this cavity, and pushed forwards so that its point may cause the walls to project, and thus serve as a guide to the Surgeon. This must then be cut upon, and the aperture thus made in the gullet enlarged, by

means of a probe-pointed bistoury, to a sufficient size to allow the removal of the extraneous substance.

Hard and perfectly indigestible foreign bodies, such as artificial teeth, are sometimes accidentally swallowed during sleep or an epileptic fit, and passing through the pharynx and œsophagus, drop into the stomach. In these circumstances, there are two courses open to the Surgeon; either to endeavor to extract the foreign substance, or to leave it, and allow it to pass, if possible, *per anum*. I think that the line of practice to be followed should depend on whether the foreign body produce irritation in the stomach or not. If it irritate, giving rise to continued efforts at vomiting, it should, if possible, be extracted. In order to do this, an ivory-balled probang should first be passed in to ascertain the situation of the foreign body. After this has been heard and felt, we may adopt the plan successfully employed by Little—who removed a hooked plate containing five artificial teeth from the stomach of a woman—of introducing a "coin-catcher" so as to search for, secure, and then extract it. In doing this, there is of course a great probability that the mass will be drawn up sideways; and that it may, if broad, hitch in the pharynx, whence it must be detached as well as the Surgeon can manage by a judicious combination of force and skill. Should the foreign body be small, as a coin, or even angular and sharp-pointed, as a plate with artificial teeth, and should it not irritate the stomach, it had better be left to pass through the intestines. When it is thus left, the patient should neither take purgatives nor opiates. Both are injurious: the purgatives by increasing the irritation of the bowels and the chance of their being wounded by sharp and projecting points from the plate; the opiates by arresting its progress. The better plan is to keep the patient in bed, perfectly quiet, and to give him an abundance of pultaceous food. By adopting this plan I have succeeded in getting a gold plate, with three molar teeth and a sharp curved clasping hook at each end, to pass without the slightest difficulty or pain four days after it was swallowed by a gentleman about 25 years of age. No attempt need ever be made to extract small coins from the stomach, as they will always easily pass through the intestinal canal.

CHAPTER XXVIII.

INJURIES OF THE CHEST.

Wounds of the Chest-Walls are not of such frequent occurrence now as formerly in the days of duelling. The soft tissues may, however, be contused, torn, or cut. The thoracic muscles, especially the pectorals, are sometimes ruptured by force applied to the arms when abducted or raised above the head. The great pectoral muscle has been torn in a boy who attempted to drop from hand to hand three rungs of a ladder at a time. Extravasation of blood, and even inflammation and abscess may result from such injury. Subpectoral abscess may occur from injury of the pectoral muscles, or of the areolar tissue beneath, or it may form without any apparent cause. The pus must be evacuated early. This may be done by making an incision through the skin and then tear-

ing through the fibres of the muscles, after the manner recommended by Mr. Hilton for the emptying of submuscular or deep-seated abscesses.

Wounds of the chest derive their principal interest and importance from the accompanying injury of the lungs, heart, or larger blood-vessels. When the soft parietes alone are wounded, the injury differs in nothing from similar lesions in other parts of the body; except that it is usually slower in healing. This is especially the case when the muscular parietes are furrowed by bullets. If the Surgeon be in doubt whether the cavity of the chest have been penetrated or not, he may endeavor to ascertain this point by careful examination with the finger; but he should never introduce a probe; it is better for him to wait and to be guided in his opinion by the symptoms that manifest themselves, rather than, by probing the wound, to run the risk of converting it into what he dreads —a penetrating wound of the chest.

INJURIES OF THE LUNG.

Contusion of the Lungs may happen from severe blows on the chest, as from falls from horseback or kicks in the side. It may be complicated with fracture of one or more ribs, usually at the posterior part. But this is not necessarily a concomitant of the injury. The symptoms are as follows. After the receipt of the blow, the patient is seized with difficulty in breathing, which is apt to become paroxysmal, so as to resemble asthma. There is expectoration, at first of mucus untinged with blood. On listening to the chest, coarse crepitation, with some dulness on percussion, will be found towards the posterior part of the lung. After some days, or possibly weeks, the patient is seized with a tolerably copious expectoration of dark, coagulated, viscid blood; and the sputa may be tinged for some time afterwards. The dyspnœa and cough become much relieved by this expectoration, and recovery gradually takes place.

It is probable that in these cases the lung is ecchymosed at the time of the injury, and that the blood extravasated in its tissue gradually breaks down when it is discharged by coughing in the viscous, semi-coagulated state above described—very different from the florid frothy sputum of recent lung-wound.

Rupture of the Lung from external violence has occasionally been observed with, but in some instances without, fracture of the ribs or other sign of injury to the thoracic walls. The symptoms and consequences of such an injury closely resemble, indeed are identical with, those of a wound of the lung; there being expectoration of frothy blood, pneumo-thorax, perhaps emphysema and subsequent pneumonia. Though very dangerous, these injuries are not necessarily fatal; but recovery may take place as after an ordinary open wound of the lung.

Wound of the Lung is the most common and one of the most serious complications of injuries of the chest. It may occur without any external wound, from the ends of a broken rib being driven inwards, lacerating the pleura and penetrating the pulmonary tissue; most frequently, however, it happens from a penetrating wound of the chest, by stab or bullet.

The **Symptoms** are sufficiently well marked. There is, in the first place, the immediate shock that usually accompanies the infliction of a severe injury, in this case amounting to extreme collapse. The patient is at the same time seized with considerable difficulty of breathing, the respiration being abdominal; this is followed by much tickling and irritating cough, and the expectoration of frothy bloody mucus, or perhaps

large quantities of pure blood. If there be an external opening, the air may pass in and out during the act of breathing; and emphysema, pneumothorax, or pneumonia will speedily supervene. On auscultating the chest immediately after the infliction of the injury, a loud rough crepitation will be distinctly audible at and around the seat of lesion.

Complications.—The principal dangers attending a wound of the lung arise from the Bleeding, both external and internal, the occurrence of Hæmothorax, Emphysema, Pneumothorax, Pneumonia, and Empyema.

1. The **Hæmorrhage** is usually abundant and often fatal; the patient vomiting or spitting up a large quantity of florid and frothy blood, by which he might be choked. If it do not prove fatal by the second day, this bloody expectoration generally ceases in a great measure in the course of forty-eight hours, giving way to sputa of a more rusty character. If the external wound be very free, there may also be copious bleeding from it; but not unfrequently the blood finds its way into the pleural sac rather than through the external aperture, and accumulates in it; and death may arise either from the exhausting effects of this internal and concealed hæmorrhage, or from suffocation through the pressure exercised on the lungs by the blood in the pleura. Although bloody expectoration to some extent at least is an almost necessary and invariable accompaniment of a wounded lung, yet I have seen a laceration in that organ three inches in length, occasioned by the projection of broken ribs, which proved fatal on the seventh day by hæmothorax and pleuritic effusion, unattended by any expectoration of blood, external hæmorrhage, or other positive sign of wound of the lung. The blood in these cases would probably be infiltrated into the loose tissue of the lung around and above the wound, where it would coagulate so as to offer a barrier against its escape into the bronchi, while it was being poured out where least resistance was offered to it—viz., at the point of injury in the pleura. The symptoms of this internal hæmorrhage, **Hæmothorax,** are those that generally characterise loss of blood, such as coldness and pallor of the surface, small weak pulse, and a tendency to collapse with increasing dyspnœa. The more special signs consist in an inability to lie on the uninjured side, with, in extreme cases, some bulging of the intercostal spaces, and an ecchymosed condition of the posterior part of the wounded side of the chest. The most important signs, however, are those that are furnished by auscultation. As the blood gravitates towards the back of the chest, between the posterior wall and diaphragm, there will be gradually increasing dulness on percussion in this situation, with absence of respiratory murmur; the other portions of the lung, however, admitting air freely.

An ecchymosis of the loins described by Valentin, and noticed by Larrey and others, occasioned by the filtration of the blood through the wound or rent in the pleura costalis into the areolar tissue of the chest, has been looked upon by some Surgeons as pathognomonic of hæmothorax; its importance, however, is secondary to that of the auscultatory signs, as in many cases it has not been met with, and in others of non-penetrating wounds of the chest it has occurred.

2. **Emphysema,** or the infiltration of air into the areolar tissue of the body, and **Pneumothorax,** or the accumulation of air into the cavity of the pleura, are not unfrequent complications of a wounded lung, although not by any means invariably met with. These accidents more commonly occur when the external wound is small and oblique, than when it is large and direct, and often happen in those cases in which the

lung is punctured by a fractured rib, without there being any external wound. In the majority of cases, emphysema and pneumothorax occur together, but either may be met with separately. The mechanism of traumatic emphysema is most commonly as follows. The costal pleura being wounded, and the lung injured, a quantity of air is sucked into the pleural sac at every inspiration, either through the external wound, or, if none exist, from the hole in the lung, thus giving rise to pneumothorax. At every expiration, the air that thus accumulates in the pleural sac, being compressed by the descent of the walls of the chest, is pumped into the areolar tissue around the edges of the wound; and if this be oblique and valvular, being unable to escape wholly through it, it finds its way at each succeeding respiration further into the large areolar planes, first about the trunk and neck, and eventually, perhaps, into those of the body generally. Though this is the way in which emphysema usually occurs, it may be occasioned otherwise. Thus, for instance, I had once under my care a woman who had extensive emphysema of the areolar tissue of the trunk from fractured ribs, but without any pneumothorax, the lung having been wounded at a spot where it was attached to the walls of the chest by old adhesions, and the air having passed through them into the areolar tissue of the body, without first entering the cavity of the pleura. Hilton has described a form of traumatic emphysema that arises from the rupture of an air-cell or bronchus without any external wound. The air, passing into the posterior mediastinum, and finding its way along the nerves and vessels in this situation, escapes through the cervical fascia which closes the upper part of the thorax, and thus reaching the neck, diffuses itself along the sheaths of the arteries and nerves, along which it finds its way into the limbs; its appearance in which is first indicated by its extending along the course of the vessels. When emphysema is complicated with fracture of the ribs, and the air surrounds the fractured ends of the bones, I have seen extensive suppuration in the areolar tissue, so that the broken parts of the fractured ribs lay bathed in pus. This will occur when the emphysema is the result of puncture of the lung by the broken rib, without any wound in the skin.

The *Symptoms of Emphysema* are very distinct. There is a puffy swelling, pale and crackling when pressed upon, at first confined to the neighborhood of the wound, if there be one externally; if not, making its appearance opposite the fractured ribs, and gradually extending over the upper part of the trunk and neck. To these parts it is usually limited: in some cases, however, which are happily rare, the swelling becomes more general, the body being blown up to an enormous size, the features effaced, the movement of the limbs interfered with, respiration arrested, and suffocation consequently induced; after death, air has been found in all the tissues, even under the serous coverings of the abdominal organs. In *traumatic pneumothorax* the auscultatory phenomena are very distinctly marked; there is a diminution or complete absence of the respiratory murmur and of vocal fremitus on the affected side, with a loud tympanitic resonance on percussion, puerile respiration in the sound lung, and considerable distress in breathing.

3. **Pneumonia** is an invariable sequence of wound of a lung, and constitutes one of the great secondary dangers of this injury; the inflammation necessary for the repair of the wound in the organ having frequently a tendency to extend to some distance around the part injured, and not uncommonly to terminate in abscess. Traumatic pneumonia resembles in all its symptoms, auscultatory as well as general, the idio-

pathic form of the disease. There are the same crepitation, dulness on percussion, and tubular breathing, as hepatisation advances; with rusty sputa, much tinged with blood in the early stages. It differs, however, from the idiopathic form in having less tendency to diffuse itself throughout the lung, and in being limited to the neighborhood of the part, and to the side that is injured. Hence it may occur in any part of the lung —the upper and middle lobes—and only invades the base of the organ if that happen to be the seat of wound. It has also a greater tendency than the idiopathic form to terminate in abscess, which, however, is often dependent on the lodgment of some foreign body, such as a piece of wadding or clothing, in the substance of the organ. Traumatic pneumonia is also usually more sthenic than that which arises from constitutional causes, and is attended by more acute and active febrile disturbance.

4. **Pleurisy and Empyema.**—Whenever the pleura is wounded, whether it be by a fractured rib or by direct open wound, and whether the lung be injured or not, pleurisy necessarily sets in, and the repair of the injury in the serous membrane is effected by the effusion of lymph, which, in all cases in which the pulmonic pleura is injured, and hence in all cases of wounded lung, causes adhesions between it and the costal pleura, and thus obliterates to a certain extent the serous sac. If this inflammation run too high, if the constitution be unsound, or if blood or a foreign body be lodged in the cavity of the pleura, there will be effusion often to a very considerable extent. The effused fluid is usually turbid serum, full of flakes of lymph, which often adhere in large layers to the inside of the chest-wall; it is generally mixed with blood from the wounded lung. This effusion will take place very rapidly, so as to half fill one side of the chest in three or four days. Eventually, there may be suppuration. The existence of these effusions of serum and pus mixed with lymph and blood, may be recognised by the ordinary auscultatory signs; dulness on percussion and absence of respiratory murmur at the lower and posterior parts of the chest, up to a level that has a gradual tendency to ascend, and that varies according as the patient is upright or recumbent, with ægophony at the upper border of the fluid, until at last, the whole side of the chest being filled with fluid, there is complete absence of all breath and voice sounds and of vocal fremitus, with increase of size on measurement, bulging of the intercostal spaces, compression of the lung against the spine; and, if the left pleura be filled, displacement of the heart towards the right side; if the right pleura be the seat of the accumulation, descent of the liver below its normal level. When the pleuritic effusion and extravasation reach such a degree as this, there is necessarily great dyspnœa, and death will usually speedily ensue.

Collapse of the Lung in wounds of the chest, consequent upon the action of the atmospheric pressure on the outside of the organ, has been more frequently spoken about than seen. The chest may be largely opened, and the full pressure of the atmosphere allowed to act on the outer surface of the lung, and yet no collapse of this organ takes place. The lung in such cases may be seen rising and falling at the bottom of the wound. When collapse of the lung occurs in the early stage, it is, I believe, owing to compression by the air sucked into the cavity of the pleura by pneumothorax. In the latter stages, it may be due to compression by hæmothorax or empyema.

The **Prognosis** in wounds of the lungs is necessarily extremely unfavorable, but less so than that of similar injuries of most of the other

viscera. The danger will depend greatly upon the mode of infliction of the wound and its extent. If the lung be wounded by the sharp end of a broken rib, recovery usually ensues. Punctured wounds of the chest, penetrating the lungs, are always very serious; but here the danger will depend partly on the depth of penetration, partly on the size of the instrument that occasions the wound. The nearer the wound penetrates to the root of the lungs, the greater is the danger from hæmorrhage by the implication of the larger vascular trunks. Gun-shot wounds of the chest are far more dangerous than stabs, owing partly to the laceration attendant on a bullet-wound, but especially to the lodgment of the bullet or other foreign bodies. Guthrie states, that more than half of those who are shot through the chest die. After the battle of Toulouse, of 106 such cases, nearly half died; and of 40 cases at the Hôtel Dieu, 20 died. Of 147 penetrating gun-shot wounds of the chest occurring in the Crimean War in the British army, 120 died; and Mouat and Wyatt state that, of 200 cases of penetrating wounds of the chest occurring in the Russian army at the siege of Sebastopol, and treated at Simpheropol, only three recovered. The Russian Surgeons, however, do not bleed in these cases, but use digitalis instead. Chenu states that, in the French army in the Crimea, of 508 cases of penetrating wounds of the chest, 467 were fatal. Longmore remarks that the apparently great mortality in the Crimea returns was largely due to the proximity of the field-hospitals to the trenches where the patients were wounded; if they had been wounded in the ordinary circumstances of a battle, many of them would never have reached an hospital. The great danger and principal cause of death in these injuries is unquestionably the hæmorrhage that ensues. This may prove immediately fatal if one of the larger pulmonary vessels be divided. As the bleeding is most abundant at and shortly after the receipt of the wound, Hennen states that, if the patient survive the third day, great hopes may be entertained of his recovery. After this period, the chief source of danger is the occurrence of inflammation of the lungs and pleura, the extent and severity of which are greatly increased in gun-shot injuries by the frequent lodgment of foreign bodies within the chest. The immediate cause of death at this stage is undoubtedly the accumulation of inflammatory effusion in the pleural cavity, as the direct consequence of the pleurisy developed by the injury. This effusion is often very rapid, and may prove fatal from the fourth to the eighth day. Emphysema is seldom a dangerous complication, though it may become so if very extensive and allowed to increase unchecked.

If both lungs be wounded at the same time, the result is almost inevitably fatal, either by the abundant hæmorrhage suffocating or exhausting the patient, or else by induction of asphyxia in consequence of air being drawn into both the pleural sacs, and thus, by compressing the lungs, arresting respiration. This, however, does not necessarily result; and there are a sufficient number of cases on record of recoveries after stab or bullet wounds traversing both sides of the chest, to show that collapse of the lungs and consequent asphyxia does not necessarily result from this double injury, which indeed has also been determined experimentally on animals by Cruveilhier.

The **Treatment** of wounds of the chest, implicating the lungs, must have reference to various sources of danger that have just been indicated.

The **Local Treatment** is very simple. If the wound have been made by a bullet, all foreign bodies that are within reach should be extracted. If there be any difficulty in doing this, it may be necessary to

enlarge the aperture; but the Surgeon must not go too deeply or perserveringly in search of them, lest he excite more irritation than the foreign body would. Light water-dressing should then be applied, no attempt being made to close the aperture, so that the escape of any extraneous substance that may have been left, or of extravasated blood, may not be interfered with.

If the wound be a clean puncture, without escape of air or much hæmorrhage, the edges may be brought together and closed by means of stitches, plasters, and collodion, so that the bleeding may be arrested, and the patient enabled to breath with more ease. Should the wound be large and deep, blood and air issuing freely through it from the injured lung, it should not be closed, but the patient should be laid on the wounded side, and a piece of water-dressing applied, otherwise emphysema or hæmothorax will certainly occur. In either case, the wall of the chest on the injured side should be fixed by long and broad strips of plaster, an aperture being left between the strips opposite to the seat of injury. Mouat states that the best results have followed this practice in the army.

In wounds of the chest-walls, the **intercostal arteries** usually seem to escape; or at least, if wounded, they do not often bleed in a troublesome manner. Should profuse hæmorrhage occur from this source, I believe that the only safe mode of arresting it is to open up the wound, and, if necessary, to enlarge it so as to reach the bleeding vessel. Should this fail, compression must be trusted to. An infinity of devices have been recommended for the suppression of this kind of hæmorrhage; but they are for the most part more ingenious than useful and but little applicable to practice, and, indeed, the complication is so rare in chest wounds, that it is needless to describe them.

Wounds of the internal mammary artery are rare, considering its exposed situation. They may, however, occur if the chest be penetrated in front through the intercostal spaces or costal cartilages. The danger in these cases is from the hæmorrhage taking place slowly into the anterior mediastinum, or into one of the pleuræ, without any external bleeding revealing the mischief. If the wound of the vessel be ascertained, an attempt should be made, by enlarging the external aperture, to seize and ligature the bleeding ends, cutting directly down upon them through the injured intercostal space; or the vessel might even be followed beneath one of the costal cartilages, if necessary, by cutting through this. Should much blood have already been extravasated, this must be removed through the external wound, by the introduction of a female catheter, or by the application of a cupping-glass over it, and the case then treated like one of effusion into the chest.

In the **Constitutional Treatment** of these injuries, the first indication consists in diminishing the quantity and force of the blood circulating through the lungs, and thus, by lessening the impulse of the heart and increasing the tendency for the blood to coagulate in the spongy pulmonary tissue and smaller vessels, to endeavor to arrest the hæmorrhage from these organs. The patient must be kept lying on the injured side, and have nothing but ice and barley-water allowed. If the hæmorrhage have been very abundant, the collapse and fainting consequent upon this may tend to induce a natural cessation of the bleeding, which thus often spontaneously ceases on the supervention of syncope. Should the hæmoptysis, however, continue or return from time to time, what should be done? Here a very considerable discrepancy of opinion exists amongst Surgeons; the question at issue being whether venesec-

tion should be adopted with the view of restraining the hæmorrhage, or the patient be treated by rest, low diet, ice, digitalis, and similar remedies. Up to the close of the Crimean War, the most experienced Surgeons were unanimous in their opinion, that the patient's safety lies in free and repeated venesection. John Bell, Hennen, and Guthrie, all concur in urging the necessity of free venesection, so as to keep down the action of the heart and arteries. Whenever this rises and the cough or hæmoptysis returns, recourse should be had to the lancet. In the Crimean campaign, Macleod states, that "those cases did best in which early, active, and repeated bleedings were had recourse to." In the official Report of the Medical and Surgical History of the War in the Crimea, venesection is advocated with equal decision as a means of arresting hæmoptysis. The writers state: "When hæmoptysis to any considerable or dangerous extent is present, venesection for the rapid induction of syncope seems not only allowable, but seems to afford the only chance of safety, and may even require to be repeated." However paradoxical or even irrational it might at first sight appear to endeavor to restrain one hæmorrhage by establishing another, yet the practice seemed established as the result of experience, and its good effects could be explained by the sudden induction of syncope by the venesection, giving time for the sealing up of the pulmonary vessels by the coagulation of blood within them.

But although this was the practice up to a comparatively recent period, the views of military Surgeons on this point seem now to have undergone a complete change; and the experience derived from the great war of the Rebellion in America and from the Maori war in New Zealand, has led to the promulgation of different doctrines and the adoption of a different line of practice. In America, venesection appears to have been generally abandoned, while reliance was placed on rest, cold, and opium for the suppression of hæmorrhage; and this practice is said to have been generally satisfactory. In New Zealand, Mouat states that bleeding was almost entirely discarded. Longmore states that, if the patient should survive, the loss of blood by venesection seems to interrupt the process of adhesion between the pleural surfaces, and other reparative measures adopted by nature, while it induces a condition favorable to gangrene, or the formation of ill-conditioned purulent effusions in large amount.

In civil practice, I think that, if the patient be young and strong, if the hæmoptysis be not so copious as immediately to threaten life and the dyspnœa great, relief will be afforded, and the chance of severe secondary inflammation lessened, by one free venesection. But I do not think that this ought to be repeated, unless at a later stage, to combat inflammation and to relieve dyspnœa arising from the engorged state of the lung and right side of the heart

If the patient survive the third day, the danger to be apprehended is no longer from hæmorrhage, but from inflammation of the lungs and pleuritic effusion. Military Surgeons formerly recommended venesection as a means both of preventing and of reducing inflammation. In modern practice, however, there is a difference of opinion: in the Crimean war, there were a number of cases of recovery from lung-wounds without blood-letting, while in other instances recovery was apparently greatly aided by free venesection. Longmore remarks that "more extended statistical information, with careful analysis of individual cases, is required before the question of the proper treatment of chest-wounds, so far as venesection is concerned, can be considered a settled one." In

civil practice, in healthy subjects, if the inflammation be confined to the lungs, and be attended by much dyspnœa, venesection will often give much relief. But when the dyspnœa arises from pleuritic effusion, bleeding must necessarily be useless, and in some cases would be decidedly injurious by still further weakening the powers of the patient. The inflammation must also be combated by a rigid diet, and by the administration of salines and antimonials. It may be necessary, however, to support the patient's strength at the same time that means are employed to reduce the inflammation. In fracture of the ribs with wounded lung, the same line of treatment requires to be adopted; but when the accident occurs in elderly people, we may advantageously substitute calomel and opium, or ammonia and senega, for the antimonials.

If extravasation of blood into the pleura be going on, its further effusion must, if possible, be arrested by the same means that are adopted for the stoppage of external hæmorrhage. When the bleeding has been checked in this way, the blood must early be let out from the pleural sac; for, if it be allowed to remain there, it will speedily putrefy, giving rise to extensive formation of pus in the cavity. In order to prevent this occurrence, the wound should be opened freely with a probe-pointed bistoury at the fifth or sixth day after the injury, so that the blood may be discharged. If it do not readily come away, a cupping-glass may be applied over the aperture, and thus it may be withdrawn. Should, however, the hæmorrhage continue notwithstanding the employment of the means indicated, Guthrie advises that the wound should be closed, so that the blood that flows into the pleural sac may, by accumulating in this, compress the lung, and thus arrest the further escape of blood from the wounded vessels: the patient at the same time should be made to lie on the injured side, in order to increase the pressure exercised upon the wounded organ. On the sixth or eighth day the chest should be tapped, or the wound opened again, in order to evacuate the extravasation, and prevent its acting as an irritant to the pleura, or by permanently compressing and condensing the lung, rendering this useless.

In all cases of purulent effusion into the chest, Guthrie advises, with good reason, that tapping should be early performed, in order that the lung may not be drawn down by false membranes in such a manner as to be unable to expand, which would lead to permanent flattening of the side and impairment of respiration.

If any extraneous body, such as a bullet, a piece of wadding, or of clothing, have penetrated too deeply into the chest to be readily extracted through the external wound, it would not be safe to make incisions or exploratory researches, with a view of extracting it; for, though its presence would increase the patient's danger, yet attempts at extraction would not only add to this, but would in all probability be fatal. In many cases, bodies so lodged become surrounded by pus, are loosened, and eventually are spat up, or appear at the external wound. In other cases, they remain permanently fixed in the chest, becoming enveloped in a cyst, and so remaining for years, without producing irritation. In this way, Hennen states, a bullet has been lodged in the chest for upwards of twenty years; and Vidal mentions the case of a man who lived for fifteen years with the broken end of a foil in his chest, which, after death, was found sticking in the vertebræ, and stretching across to one of the ribs.

The routine system of bandaging or strapping up the chest tightly must not be followed in all cases of fracture of the ribs. There are two conditions in which it is not advisable. The first is, where the fragments

of the broken rib are sharp and angular, and, projecting inwards on the pleura and lung, produce pain, distress, and no slight danger of wounding these structures if pressed down upon them. Secondly, there are cases where the lung has become compressed by the effusion of air, serum, or blood into the pleural sac. In such cases, tight bandaging of the chest will produce great distress; for, the lung on the injured side being already rendered useless, or nearly so, as a respiratory organ by the compression, respiration is altogether carried on by the lung on the uninjured side. If the chest be uniformly or tightly compressed, the use of this lung is also interfered with to such an extent, that a semi-asphyxial condition may ensue. In such cases, rather than bandaging the whole chest, the better plan is to strap up only the injured side from spine to sternum, so as to restrain its movements and leave the sound side free.

The **Treatment of Emphysema** consists of little in addition to what is called for by the wounded lung. In many cases, indeed, the air becomes rapidly absorbed, without the necessity of any local interference. In others, again, the pressure of a bandage may be required. If, however, the emphysema be so extensive as to interfere with respiration, the external wound, if any exist, must be freely opened, and scarifications made into the areolar tissue, so as to give exit to the air. I doubt whether emphysema alone can ever prove fatal. If, however, both sides of the chest be opened, it is possible that the accompanying pneumothorax may so interfere with the due expansion of the lungs, as to produce an asphyxial condition that may end in death.

Hernia of the Lung, or Pneumocele.—This is an extremely rare affection. It consists in the protrusion of a portion of the lung at some part of the thoracic walls, so as to form a tumor under the skin. It has most frequently been met with after an external wound, under the cicatrix of which the hernial swelling has appeared; but it has been known to occur from fractured ribs without any wound, and even from violent straining during labor. I have seen a case in a man who gained his livelihood by playing the cornet In these cases it is probable that, the intercostal muscles and costal pleura having been divided or ruptured, by the efforts of the patient, and not having united afterwards, the lung has, during expiration, gradually insinuated itself into the aperture so formed, until at last the hernial tumor has appeared. This protrusion may take place at any part of the thoracic parietes; thus Velpeau observed it in the supraclavicular region of a girl; but most commonly it occurs on one or other side of the chest. The tumor may attain a large size; I have heard Velpeau state that he had seen one half as large as the head. It does not appear to shorten life.

Almost the only case that has fallen under my own observation is one that I saw in 1839, in Velpeau's wards at La Charité; and as the signs of the affection were well marked in this case, I may briefly relate it, from notes taken at the time. A man twenty-nine years of age, left handed, received in a duel a sword-wound at the inner side of, and a little below the left nipple; he lost a considerable quantity of blood, but did not spit up any. The wound healed in about a fortnight, shortly after which he noticed the tumor, for which he was admitted three months and a half after the receipt of the injury. On examination, an indurated cicatrix about half an inch in length was found a little below, and to the inner side of, the left nipple. On inspiring or coughing, a soft tumor of about the size of an egg appeared immediately underneath the cicatrix, which it raised up; it subsided under pressure, or when the patient ceased to

inspire or to cough; and its protrusion might be prevented by pressing the finger firmly on the part where it appeared, when a depression was felt in the intercostal muscles. If the fingers were slid obliquely over the tumor, it yielded a fine and distinct crepitation, exactly resembling that produced by compressing a healthy lung, and the spongy tissue of the organ could be distinguished. On applying the ear, a fine crackling and rubbing sound was distinctly perceived; the tumor was resonant on percussion. The portion of protruded lung did not appear to re-enter the chest on expiration, but was firmly fixed in its new situation. No treatment was adopted in the case, nor does any appear admissible in similar instances.

The only affection with which a hernia of the lung can be confounded, is a circumscribed empyema which is making its way through the walls of the chest. Here, however, the dulness on percussion, and the absence of respiratory murmur, and of crackling under the fingers, will readily enable the Surgeon to make the diagnosis.

It occasionally happens in extensive wounds of the chest, that a portion of the lung protrudes during efforts at expiration. If the wound be free, the protruded lung may return on pressure or during inspiration. If left unreturned, it soon becomes livid and gangrenous; in these circumstances it may be removed by the knife or ligature; but Guthrie advises that the protruded part should never be separated from the pleura costalis by which it is surrounded at its base, so that the cavity of the thorax may not be opened; the wound must then be closed in the usual way.

WOUNDS OF THE HEART AND LARGE VESSELS.

Wounds of the Pericardium.—The pericardium may be wounded with or without penetration of the chest, and with or without injury of the heart. Without wound of the chest-wall, it may be lacerated by a severe contusion; with penetration of the chest-wall, it may be wounded by a stab or by gun-shot.

Laceration of the Pericardium may take place from a severe blow on the chest. In this way I have seen the membrane split down logitudinally for two or three inches, from contusion received in a fall.

The **Pericardium may be wounded** by a stab without the heart being injured. Thus I have seen a wound of the pericardium in a young man, inflicted by his sweetheart with a sharp-pointed pair of embroidery scissors.

The pericardium may be bruised or cut by an oblique gun-shot wound without damage to the heart. This I have seen happen with a pistol-bullet penetrating the chest obliquely.

In injuries such as these, collapse to a greater or less extent is always met with. This is followed by inflammation; the ordinary auscultatory signs of adhesive or effusive pericarditis, such as friction or creaking, with extended dulness on percussion, become perceptible; and there are intense thoracic oppression, dyspnœa, and restlessness, with pallor and a small rapid pulse.

In some cases of wound of the pericardium, one of the *coronary vessels* may be injured, and blood become effused into the sac, between it and the heart. In these cases the interposition of the layer of blood causes the heart sound to be weak and remote, the impulse of the apex to be indistinct or imperceptible, and the cardiac dulness to be widely diffused.

The *Prognosis* of cases of injury of the pericardium is necessarily

very unfavorable. The heart may become choked by the intrapericardial extravasation of blood or the inflammatory effusion.

The *Treatment* of these cases of wound of the pericardium presents nothing special. It must be conducted on those ordinary medical principles that guide us in the management of similar cases arising from other than traumatic causes.

Wounds of the Heart.—The heart may receive a wound which does not penetrate through the walls; or one or more of its cavities may be opened by the agent that inflicts the injury. Most commonly the wound is inflicted by stab or gun-shot, and then generally no foreign body is lodged in the cardiac cavities or substance. But in some instances bullets, as well as pieces of stick, needles, iron pins, and other substances, have been lodged and encysted in the substance of the ventricles.

In the vast majority of cases, wounds of the heart are immediately fatal, but they are not necessarily or invariably so. Much will depend on whether they penetrate or not into the cavities, and on the extent of the injury that the heart has sustained.

Non-Penetrating Wounds may be fatal at once from direct shock to the heart; or the patient may survive a few hours or days and then die of pericarditis; or he may recover and live for years, as in a case reported by West of Birmingham, in which the man lived for four and a half years. After death, evidences of extensive and severe pericarditis were found, and there was a linear cicatrix half an inch long in the anterior part of the right ventricle.

Penetrating wounds of the Heart are almost invariably at once fatal from loss of blood and shock to the organ and system. This is especially the case if the cavities be largely opened, or much of the heart-substance destroyed. But there are many exceptions to this general law of fatality.

Jamain has collected 84 cases in which people have lived for considerable periods after having received a wound of the heart. Of these, in 35 cases the right ventricle was wounded, and the sufferers lived from four and a half hours to twenty-three days. In 19 cases the injury was to the left ventricle; and of these life was prolonged to periods varying from half an hour, in two cases, to six months in one instance. Both ventricles were wounded in five cases in patients living from one hour to nine and a half months; the right auricle in seven cases, the patients living from seven hours to twenty days; the left auricle in two cases, in which the patients lived respectively one and two days. In many cases, the patient has been known to walk or to run some considerable distance after the receipt of the injury.

Ollivier and Sanson have collected 29 cases of penetrating wounds of the heart, which did not prove fatal in the first forty-eight hours after the receipt of the injury. On analysing these it would appear that the rapidity of death depends greatly on the direction of the wound and the part of the organ injured. When the wound is parallel to the axis of the heart, it is not so speedily fatal as when in a transverse direction, and wounds of the auricle are more immediately followed by death than those of the ventricle; the irregular contraction of the different planes of muscular fibre that enter into the formation of the wall of the ventrilce tending to obstruct the free passage of the blood through the wound, and perhaps to close it entirely. The size of the wound, however, will necessarily influence the result more materially than its direction. Not only, however, may a person live a considerable time after having received a penetrating wound of the heart, but there are many cases on

record in which life has been prolonged even though a foreign body were lodged in the cavities or substance of the organ. Thus Ferrus relates the case of a man who lived for twenty days with a skewer traversing the heart from side to side; and Roux that of a man who lived twenty-one days with a portion of a file, with which he had stabbed himself, in the wall of the left ventricle. Davis and Stewart found a piece of wood, three inches long, in the right ventricle of a boy, who lived five weeks after the accident had happened; Carnochan relates a case in which the wounded man survived eleven days with a bullet deeply lodged in the substance of the apex of the heart; and Latour records the case of a soldier who lived for six years after being wounded with a musket ball in the side, and in the right ventricle of whose heart the bullet was found lodged, lying against the septum.

Ollivier, Jamain, West, and especially Fischer, have collected statistics with regard to the relative frequency of wounds of the different cavities of the heart. Fischer has collected 452 cases, in which the right ventricle is stated to have been wounded in 123, the left ventricle in 101, and both ventricles in 26. In 28 cases the right auricle, and in 13 the left, was the seat of injury. The apex of the heart was wounded in 17. The reason of the frequency of wound of the right ventricle is the obvious anatomical fact that it lies more anteriorly than the left, and hence is more likely to be injured by wounds that penetrate the chest from the front—this being the most common situation of wounds that injure the heart. According to Fischer, in 258 cases the heart was wounded from the front of the thorax, in 26 from the abdomen, in 11 from behind, and in 5 from the side.

The pericardium is necessarily wounded in most cases of wounds of the heart. But there are instances on record in which a ball has entered the chest and caused a laceration of the heart-substance without penetrating the pericardium, which escaped in consequence of its firmness and fibrous character. Again, as has already been stated, the pericardium alone may be injured: Fischer has collected 51 such cases.

The **Symptoms** of a wound of the heart, when immediately fatal, are as follows. The person struck springs up convulsively, or falls suddenly prostrate; sometimes with, sometimes without, a sudden and sharp shriek. Death results from hæmorrhages, which will be profuse, and pass out beyond the pericardium, if the wound be large and that membrane be widely opened; or into the pericardium, with choking of the heart from compression, if the wound be small. In either case, death is hastened by collapse arising from shock to the central organ of circulation itself, and to the system at large from the wound of so important an organ.

If the wound be small and death be not immediate, there are evidences of great shock in the intense depression of vital power, the pallid and anxious countenance, and the relaxation of the limbs. The action of the heart itself is tumultuous, weak, and irregular; the pulse is scarcely perceptible; the breathing is frightfully embarrassed. If the patient survive a few days, these symptoms partially and intermittingly subside; and the ordinary auscultatory signs of pericarditis come on—friction and creaking sounds, with diminished and distant impulse, and perhaps widely spread dulness in percussion. To these may possibly be added evidences of endocardial inflammation. Of these consecutive inflammatory complications and of their consequences the patient will most probably ultimately die, though perhaps at a remote period and after prolonged suffering.

Ruptures of the Heart from External Violence, without penetrating wounds of the chest, are not of frequent occurrence. Gamgee has, however, collected 27 published cases of this accident. On analysing these he finds that in at least one half of the cases, the pericardium was intact; 12 of the ruptures were on the right, 10 on the left side. The right ventricle was ruptured in 8, and the left in 3 cases; whereas the left auricle was torn in 7, and the right only in 4 instances. Death is usually nearly instantaneous, though there are instances on record in which the patient has made some exertion after the rupture had taken place, and has even lived for several hours. In a case of rupture of the right auricle recorded by Rust, the patient survived fourteen hours. In most of the recorded cases, the injury occasioning the rupture was directly applied to the region of the heart. But instances are not wanting in which this organ has been found ruptured through one or both ventricles, or in one of the auricles, without any evidence of direct injury in the cardiac region—the patient having fallen upon his head or shoulders, or having been merely thrown forcibly to the ground with serious injury to the lower extremities. In some of these cases, there is reason to believe that the rupture was produced by the spasmodic violence of the contractions of the heart, under the influence of great mental emotion or fear. The only case that has occurred in my practice was that of a man brought into the Hospital dead, having fallen from the top of a cart. The right shoulder was bruised, and the clavicle broken—showing clearly that he had pitched on that side; there was no other bruise about the body, or evidence that the wheels had passed over him. On examination, the liver was found extensively torn, in fact smashed, and the pericardium was distended with blood—there being a triangular ragged aperture at the anterior part of the auricular appendage of the left auricle, through which it had escaped.

Wounds of the Aorta and Vena Cava are usually as immediately fatal as those of the heart itself. In this respect, they resemble wounds of the auricles rather than those of the ventricles. Heil has, however, recorded a case in which the patient recovered and lived for a twelvemonth, after receiving a stab that penetrated the ascending aorta.

CHAPTER XXIX.

INJURIES OF THE ABDOMEN AND PELVIS.

INJURIES OF THE ABDOMEN AND ABDOMINAL VISCERA.

Injuries of the abdomen occur frequently. They may be divided into Contusion of the Abdomen, with or without rupture of internal Organs; Non-penetrating wounds; and Penetrating Wounds, either uncomplicated, or conjoined with Injury or Protrusion of some of the Organs contained in this cavity.

Contusions of the Abdominal Walls from blows or kicks usually terminate without serious inconvenience, but in some cases are followed by very acute peritonitis, which may prove fatal.

In other cases, the abdominal muscles may be ruptured, although the skin may remain unbroken. A man was admitted under my care into

the Hospital, having received a blow from the buffer of a railway carriage upon his abdomen. He complained of a great pain at one spot; and, on examination after death, we found the rectus muscle torn across without injury either to the integuments or the peritoneum. If the patient live, an injury of this kind is apt to be followed by atrophy of the muscular substance, and perhaps by the occurrence of a ventral hernia at a later period. Occasionally the contusion is followed by abscess in the abdominal wall, which has a tendency to extend widely between the muscular planes. The abscesses should be opened early, lest they burst into the peritoneal cavity and occasion fatal inflammation.

Buffer-Accidents.—A contusion of the abdomen is often associated with **Rupture of some of the Viscera.** In military practice these internal injuries are met with in the so-called "wind-contusions;" in civil practice they commonly result from blows, kicks, the passage of a cart-wheel over the abdomen, or the squeeze of the body between the buffers of two railway carriages. These "*Buffer-accidents*," are of common occurrence in hospital practice, resulting usually from the carelessness of railway guards and porters, who, trying to pass between carriages in motion, are caught and squeezed between the buffers. In these cases the most fearful internal injuries occur, often without any external wound. A man was admitted under my care into University College Hospital, in whom the liver, stomach, spleen, and kidneys, were crushed and torn; the heart was bruised, being ecchymosed on its surface, and one of the lungs was lacerated, without any rupture or bruise of the skin or fracture of the ribs. In this way any of the abdominal organs may be torn or contused, the particular one injured depending on the situation of the blow. The organ that is most frequently crushed in this way is the liver, owing to its large size and the unyielding nature and ready lacerability of its structure; the other solid organs, such as the spleen and kidneys, do not suffer so frequently: the pancreas I have never seen injured Among the hollow organs the stomach most commonly suffers, and it is especially likely to do so if struck while distended by food. Any portion of the intestinal canal may be lacerated. I have seen the duodenum, the ileum, the jejunum, and the large intestine ruptured in different cases: the mesentery likewise may be torn, and the spermatic cord snapped across.

The sufferer usually dies in the course of a few hours, or at the utmost at the end of two or three days after the receipt of these severe injuries, from hæmorrhage into the abdominal cavity, conjoined with shock. It is seldom that life is prolonged sufficiently for peritonitis to be set up, though this is the chief danger to be apprehended in those cases that survive the more immediate effects of the accident. The shock of itself may prove fatal, though there be but little apparent internal mischief; thus, I have seen a man die collapsed eight hours after a buffer-accident, in whom no injury was found except a small rupture of the mesentery, attended with but very slight extravasation of blood. The severity of the shock, amounting often to prolonged and complete collapse, is one of the most remarkable phenomena attending these injuries. It is difficult to account for it, except on the supposition that it is due to wound or concussion of the great sympathetic nerve and its large abdominal ganglia. To whatever cause it may be referred, it is certain that it is greater than that which follows a corresponding injury, unattended by loss of blood, of any other part of the body except the central portions of the cerebro-spinal nervous system. The continuance of the shock may be maintained, and its intensity increased, by the syncopal effect

of internal hæmorrhage, which, when the solid organs are ruptured, is the most common cause of death. So far as my experience goes, I would say that the shock is most severe in injuries of and about the stomach, probably from damage to the great solar plexus. Hæmorrhage is the most usual cause of death when the liver and spleen are ruptured; and the patient usually dies of acute peritonitis when the intestine has been torn across. It does not follow, however, that these injuries are necessarily fatal. Patients have lived after all the signs of rupture of the kidney, the passing of bloody urine, and the presence of circumscribed peritonitis, and, when death has occurred at a later period, cicatrices have been detected in the organ. A patient was admitted under my care into the University College Hospital for a severe blow upon the back from the buffer of a railway carriage, followed by hæmaturia and other symptoms of renal injury; on his death from pneumonia nine weeks after the accident, an extravasation of blood, with the marks of recent cicatrisation, was found in the left kidney.

Rupture of the liver is by no means speedily or even necessarily fatal. It may be, and usually is so, from great extravasation of blood or of bile; but if neither of these be largely poured out, the patient may live for some considerable time, though he may eventually succumb to traumatic peritonitis. A man was once admitted under my care into the University College Hospital, who had been crushed between the buffers of two railway carriages. He was collapsed and apparently moribund, but rallied in a few hours. Two days after the accident, great pain and tenderness in the right hypochondrium were complained of, and dulness on percussion was found to extend as low as the umbilicus. He became jaundiced, and there were symptoms of low peritonitis; these were followed by great swelling of the abdomen, which became tympanitic; the peritonitis continued, and symptoms of intestinal obstruction came on, the dulness increasing, with fluctuations in the flanks. He died on the sixteenth day after the accident, and on examination no less than 240 ounces of bilious fluid, mixed with flakes of lymph, were found in the abdominal cavity; the obstruction of the bowels being dependent on the pressure of this effusion, and on the matting together of the intestines by lymph. There was a large rent in the thick border of the liver, which was beginning to cicatrise.

Injury over the region of the liver, probably occasioning laceration of that organ, followed by peritonitis and jaundice, may be recovered from. Of this I have had several instances in my own practice. The following is a good example. A man, about forty years of age, fell from a scaffold to the ground. In falling, he struck violently against a beam, injuring his abdomen on the right side. He was brought to the Hospital in a state of collapse, from which he slowly rallied. There was no injury but that of the abdomen, of which he complained much, more particularly over the region of the liver, which was very tense. Peritonitis speedily set in, with great tympanitic distension of the belly, vomiting of bilious matter, and the passage of uncolored stools. These symptoms continued many days, and the man became jaundiced. As the tympanites subsided, it was found that there was dulness on percussion in both flanks, and that the fluid, which was evidently extravasated into the peritoneal cavity, rose to a level with the umbilicus when he lay on his left side, which he did habitually. He was treated with opium, and put on a very mild unstimulating diet. He gradually but slowly recovered, the vomitings becoming less frequent, and eventually ceasing, and the fluid in the abdomen being slowly absorbed, bile at the same time appearing in

the motions; but the tenderness over the region of the liver continued up to the time at which he left the Hospital, nearly two months after the accident. In this case the long and severe collapse, the seat of pain and injury, the peritonitis, the bilious vomitings, and the white stools, all pointed to serious injury of the liver and the intestines; and rapid intra-abdominal extravasation could only be accounted for by rupture of that organ.

The *Symptoms* of an internal abdominal injury are often extremely equivocal, and will necessarily vary according to the organ injured.

If the **Spleen** have been lacerated, there will be all the effects of severe shock of the system, accompanied by those of internal hæmorrhage; coldness, and pallor of the surface, a small and feeble pulse, anxiety of countenance, and great depression of the vital powers, with pain at the seat of injury, and perhaps dulness on percussion from extravasated blood. These symptoms speedily terminate in death.

If the **Kidneys** be injured, there will commonly be a frequent desire to pass urine, and this will be tinged with blood, often to a considerable extent. After the discharge of blood ceases, the urine will become albuminous, and may continue so for a great length of time. On examining such albuminous urine under the microscope, it will generally be found to contain a few blood-corpuscles and possibly some casts of tubes, with mucus and epithelial scales, showing the existence of inflammation in the kidney. It is a remarkable and important practical fact that, so far as my experience goes, I have never seen albumen in the urine as the result of renal injury, unless it had been preceded by blood. The absence of blood from the urine must not, however, be taken as an indication that the kidney is not injured; it may be so disorganised as to be totally incapable of secreting, and consequently no bloody urine finds its way into the bladder. A man was admitted into the Hospital under my care for a buffer-injury of the back; he passed urine untinged with blood, but after death his right kidney was found completely smashed by the blow, and there was an extensive extravasation of blood in the cellulo-adipose tissue around it; here it was evident that the disorganisation was so sudden and complete that no urine could find its way into the bladder. In another case, in consequence of a fall from a window, an elderly man died in the course of an hour, having struck his back and sustained several fractures of the limbs. The left kidney was ruptured in a starred manner, with extensive extravasation of blood into the tissues around it, but there was not a tinge of blood in the urine which was retained in the bladder.

If the **Liver** have been ruptured, pain over the region of that organ, dulness on percussion from extravasated blood, and great collapse, followed, if the patient live, by diffused traumatic peritonitis, bilious vomitings, white stools, and jaundice, will, with sufficient precision, indicate the true nature of the injury. Bernard has further shown that contusions of the liver are followed by traumatic saccharine diabetes.

When the **Stomach** is ruptured, the nature of the accident is usually revealed by bloody vomiting; and when the **Intestines** have been torn, by the admixture of blood with the stools, if the patient live long enough to pass any. These signs, however, do not occur in all cases. A man was admitted to the Hospital under my care, whose abdomen had been squeezed between a cartwheel and a lamp-post; during the five hours that he lived he vomited several times, bringing up a meal which he had taken immediately before the accident. In the vomited matters there was no blood to be seen; but on examination after death it was found

that not only the liver and spleen were ruptured, but the stomach was torn almost completely across near the pylorus.

Emphysema of the Abdominal Wall, and subsequently of the trunk generally, may result from the escape of flatus from wounded intestine into the subperitoneal areolar tissue, and thence into the more superficial planes. When this takes place, the same doughy, puffy, inelastic, crepitating swelling of the subcutaneous areolar tissue, that is met with in thoracic emphysema, is observed. It usually commences in one or the other flank, and may then creep up towards the axilla, or in front of the abdominal wall.

As a diagnostic sign, this form of emphysema is valuable in those cases in which the intestines have been injured, either without any wound of the abdominal parietes, or, if there be wound, without protrusion of the injured portion of gut. In two of the cases in which I have observed it, this condition was the only positive sign of intestinal injury. In one case, the transverse duodenum had been ruptured where uncovered by peritoneum, by a buffer-accident; and in the other the rectum and meso-rectum had been traversed by a pistol-ball. In both these cases the emphysema was extensive, the flatus having directly passed into the subperitoneal areolar tissue. In other cases it may in the first instance pass into the cavity of the abdomen, and render that tympanitic, and then, as in thoracic emphysema after pneumothorax, escape into the areolar tissue at the edges of the wound. In a case under my observation, it occurred after tapping the bladder through the rectum. The flatus escaped, after the removal of the cannula on the sixth day, through the small aperture in the walls of the gut into the subperitoneal areolar tissue of the pelvis, thence, through the sciatic notches, down the posterior and outer part of the thighs and the flanks.

The diagnosis of abdominal emphysema from thoracic emphysema and from putrefactive infiltration of air into the areolar tissue requires to be made. In the first case, the diagnosis may readily be effected by observing an absence of the signs of thoracic injury, and by the situation of the emphysema in the posterior or lateral abdominal wall, or around the lips of a wound. From putrefactive infiltration with air, the abdominal emphysema is easily distinguished by the cause, and by the absence of low inflammation of the areolar tissue.

The **Treatment** of the various injuries of the abdomen that have just been described is very simple. If the symptoms indicate laceration of one of the viscera, little can be done during the state of collapse supervening on the accident, beyond keeping the patient quiet, and employing the means that have been recommended for lessening the effects of shock. If the patient survive this period, we must guard against peritonitis, and limit, if possible, the extravasation of blood into the abdomen, should there be indications of its occurrence, by the employment of treatment that will presently be described.

Wounds of the Diaphragm may be occasioned by stabs or by gunshot injury. Sometimes, however, this muscle is perforated by the fragment of a broken rib without external wound. The lesion, though not in itself mortal, is necessarily usually complicated with so much visceral injury as to be very generally followed by death. If the patient survive, the aperture may be blocked up by a false membrane, to which the adjacent lung will probably adhere; and thus the separation between the cavities of the chest and abdomen will be maintained. Should this reparative action not take place, a hernial protrusion of some of the

abdominal viscera may take place into the pleural cavity, as will be more fully described when we speak of "Diaphragmatic Hernia."

WOUNDS OF THE ABDOMEN.—**Wounds of the Abdominal Wall that do not penetrate the Peritoneal Cavity,** if uncomplicated with internal injury, usually do well, and merely require to be treated on ordinary principles. If they be incised, and so extensive as to require sutures, the stitches should be introduced through the skin alone, never through muscular or tedinous structures, the union of which could not be effected in this way; the parts injured must also be relaxed by careful attention to position. When they are the result of gun-shot injury, they suppurate extensively, and are very slow in healing.

Wounds that Penetrate the Cavity of the Abdomen are of especial interest, on account of the frequency with which they are complicated with peritonitis, and with injury of the viscera. They may, for practical purposes, be divided into 1, those that Penetrate the Peritoneal Sac, without wounding or causing the protrusion of any of the contained organs; and 2, those that are complicated with Protrusion or Wound of some of the Viscera.

1. **Penetrating Wounds of the Abdomen, without Visceral Protrusion or Injury,** are often somewhat difficult to distinguish from simple wounds of the abdominal wall, though the escape of a small quantity of reddish serum may reveal the nature of the accident. In these cases the Surgeon should be careful not to push his examination too far, by probing or otherwise exploring the wound, lest he really perforate the peritoneum which was previously intact. The cavity of the peritoneum has often been perforated from front to back by bullet-wounds or sword-thrusts, without there being any sign of visceral injury. In the absence of peritonitis or other signs of mischief, the wound must be treated as a simple one of the abdominal wall, and any complication that may occur must be met in the way that will immediately be described.

2. In a **Penetrating Wound with Protrusion or Injury of the Viscera,** the risk is necessarily greatly increased; here the chief danger is from peritonitis, induced either by the wound, by the extravasation of the intestinal contents into the peritoneal cavity, or by the accumulation of blood in it. It but seldom happens that death results from hæmorrhage in these cases, though this may, of course, occur if any of the larger vessels be injured.

Protrusion of uninjured intestine, mesentery, or omentum may take place through the wound in the abdominal wall. This protruded mass is always very large in comparison with the aperture from which it escapes, the sides of which, being overlaid by it, constrict it rather tightly, so as to form a distinct neck to the protrusion. If left unreduced, the mass speedily loses its polish and bright color, becoming dull and livid from congestion; it then inflames, and soon becomes gangrenous from the pressure exercised upon it by the sides of the aperture through which it has passed.

In many cases *the protruded intestine is wounded.* The existence of this further injury will readily be ascertained by the escape of flatus, or of the more fluid contents of the gut. The characters of the wound vary, as Travers has pointed out, according to its size. If it be a mere puncture, or even an incision two or three lines in length, eversion or prolapsus of the mucous membrane will take place, so as to close it sufficiently to prevent the escape of the contents. If the aperture be above four lines in length, this plugging of it by everted mucous membrane

cannot take place, and then the contents of the bowel are more freely discharged; but, even in these circumstances, there will be a tendency to the protrusion of the membrane, which forms a kind of lip over the edge of the cut.

A wounded intestine which does not protrude, but remains within the peritoneal sac, exhibits the same phenomena. In these cases, however, there is the additional danger of the **extravasation of the intestinal contents** into the peritoneum. This extravasation, unquestionably one of the greatest dangers that can occur in wounds of the abdomen, inasmuch as by its irritating qualities, the feculent matter gives rise to and keeps up the most intense peritonitis, takes place less frequently than might be expected. For this there are several reasons. In the first place, as we have already seen, if the wound in the gut be below a certain size, there is a natural tendency to its occlusion by eversion of the mucous membrane. Besides this, it must be borne in mind that, though in ordinary language we speak of the "cavity" of the abdomen, there is in reality no such thing; there being no empty space within the peritoneal sac, but the whole of the visceral contents of the abdomen being so closely and equably brought into contact by the pressure of the abdominal muscles and of the diaphragm, that it requires some force for the intestinal contents to overcome this uniform support, and to insinuate themselves between the coils of contiguous portions of intestine. The influence exercised by the continuous pressure of the abdominal walls upon the intestinal contents, is well shown by the greater facility with which these escape from a portion of wounded intestine that has been protruded, than from one that is still lying within the abdomen. In the former case, fæces will escape from a much smaller aperture than in the latter, in consequence of the gut not being supported on all sides by the uniform pressure to which it is subjected within the abdomen. It is seldom, indeed, that fæces are extravasated from gut that is not protruding, unless it be very full at the time of the injury, or the wound in it be very extensive. The influence of the equable pressure of the abdominal contents in preventing the escape of fæces was well illustrated in a case in University College Hospital, of a man who was shot through the abdomen. The intestines, which contained much feculent matter, were traversed by the bullet in four places. He lived twenty-four hours, and yet no feculent extravasation took place. In another case to which I was called, that of a young gentleman who had been accidentally shot through the abdomen with the ramrod of a horse-pistol, the descending colon was cut completely across, and the small intestines perforated in two places; and yet no extravasation took place, though he survived the accident two days.

Blood is extravasated more readily than the intestinal contents in wounds of the abdomen. This is in a great measure owing to the *vis à tergo* in an artery of moderate size, such as one of the branches of the mesenteric, being sufficient to overcome the equable pressure and support of the abdominal walls.

Extravasations, whether of fæces or of blood, when once formed, have little tendency to diffuse themselves, but become localised in the neighborhood of the part from which they were originally poured out; owing, in the first instance, to the surrounding pressure, and at a later period, to the deposit of plastic matter between the folds of intestine and the neighboring viscera. In this way the diffusion of irritating matters, through the abdominal cavity is prevented, and the likelihood of the occurrence of wide-spread and fatal inflammation is much diminished.

The existence of these extravasations may, in many cases, be recognised by dulness on percussion around the wound, by the localised swelling to which they give rise, and sometimes by their escape through the external aperture.

Treatment.—In the treatment of penetrating wounds of the abdomen, we must first consider the management of the injured parts; and afterwards, the prevention or cure of the consecutive peritonitis.

If the wound **have not implicated any of the abdominal viscera,** it must be closed by relaxing the abdominal muscles by position, by introducing a few points of suture through the integuments, if it be extensive, and by applying a compress and plaster, supported by a bandage. The patient should then have a full dose of opium; about two grains of solid opium or forty minims of the liquor sedativus, which must be repeated in from four to six hours, so that the effects may be kept up. I prefer in these cases the solid opium of which as much as from six to eight grains may be given in twenty-four hours. The patient should be kept perfectly quiet in bed, and no nourishment given for a few days, except barley-water and ice. The bowels should not be opened by aperient medicine, lest abdominal irritation be set up, but oleaginous enemata may be administered at the end of a week or ten days.

If **the intestine be wounded but not protruding,** we must endeavor to limit the peritonitis that will ensue, and also to prevent feculent extravasation. The patient should be laid on the injured side with the wound dependent, so as to allow the fæces to escape through it, if disposed to do so. If the injury be about the umbilicus, he must lie upon his back with the knees drawn up and bent over a pillow. Opium must then be administered in the full doses already indicated, and repeated in grain doses at least every fourth or sixth hour, so that the system may be kept well under its influence. The value of opium in these cases is very great; it not only seems to moderate the inflammation of the peritoneum, but it is of the greatest utility in preventing extravasation of fæces. This it does by arresting the peristaltic movement of the intestine, and thus keeping it from change of position. This arrest of the intestinal movements also tends greatly to the closure of the wound. Travers has shown experimentally, and his investigations have been confirmed by subsequent observations on the human subject, that wounds of the intestines are closed by lymph that is thrown out, not only from the contiguous peritoneal surfaces of the part actually injured, but from that of neighboring coils; so that the aperture in the gut becomes permanently glued and attached to the structures in its vicinity. In order that this process should take place, it is necessarily of importance that the movements of the bowels be paralyzed; and it is a beautiful provision of nature that the very inflammation which closes the wound, arrests that peristaltic action, the continuance of which would interfere with its agglutination to, and closure by, the neighboring parts. Until therefore, the necessary degree of inflammation to effect this is set up, the intestinal movements must be arrested by opium.

If **extravasation of feculent matter** have taken place into the abdomen, an attempt may be made to facilitate its escape externally by removing the stitches and plasters, and placing the patient on the injured side, so that this may be most dependent; should the lips of the wound have already become adherent to one another, they may even be gently and carefully separated by the introduction of a probe, and in this way an outlet afforded for the effused matters.

When **a portion of intestine or of omentum has protruded**, it should be replaced as speedily as possible, before strangulation has occurred, which may occasion gangrene. The abdominal muscles should be relaxed by bending the thigh upon the abdomen, when the Surgeon may gradually push back the protrusion by steady pressure upon it; he must not, however, employ any force, nor any rough handling of the exposed and delicate parts; but if their return cannot readily be effected, owing to the constriction of the neck of the tumor, the aperture through which they have escaped must be carefully enlarged in a direction upwards, by means of a probe-pointed bistoury, or a hernia-knife guided by a flat director. The incision necessary to enlarge the opening sufficiently for reduction, need not exceed half an inch in length. In replacing the protruded parts, whether by the aid of incision or not, care must be taken that they are fairly put back into the cavity of the abdomen, and not pushed up into the sheath of the rectus, or into the subserous areolar tissue lying before the peritoneum; an accident that would be fatal by allowing the constriction of the neck of the protrusion to continue unrelieved. In effecting the return, the Surgeon should not push his finger into the abdomen, but must content himself with simply replacing the protruded gut or omentum, and allowing it to remain in the immediate neighborhood of the wound, in the abdominal wall, to which it will contract adhesions; and through which its contents may escape, in the event of any sloughing being set up in it. If the protrusion be inflamed, it must equally be replaced without delay; but should the intestine have become gangrenous from continued constriction and exposure, no attempt at reduction should be made, but an incision must be carried through it, so as to allow the escape of fæces, and the formation of an artificial anus. If the protruded omentum be gangrenous, it must be excised on a level with the peritoneum, to the aperture in which that portion lying within the abdomen will have contracted adhesions.

If **the intestine that protrudes be wounded**, the treatment of the aperture in the gut will call for special attention; and Surgeons have been somewhat divided as to the question of the propriety of stitching it up. Scarpa and S. Cooper were opposed to this practice on the ground that it does not prevent extravasation, and that the stitches produce irritation by acting as foreign bodies. They proposed to return the wounded gut, taking care, however, to leave the aperture in it to correspond with that in the abdominal wall, so that an artificial anus might be established by the adhesion of the edges of the openings to one another, and by that means prevent extravasation. To this practice the great objection exists, that extravasation will probably occur before there has been time for the effusion of lymph, and the agglutination of the contiguous surfaces; besides which, it is impossible to secure the necessary correspondence between the two apertures, the wounded gut being very liable to alter its position after it has been replaced. It has also been found by experience that one of the objections urged against the employment of a suture, that it cannot prevent the escape of feculent matter, is not valid. If it be properly applied, it may effectually do so, as was shown by a successful case under my care, the details of which were published in the *Lancet* for 1851. That the stitches act as sources of irritation to any extent, is also doubtful. Travers found by experiment that, when a wounded gut was sewn up, and returned into the abdomen, the sutures quickly became bridged or coated over with a thick layer of lymph, and, gradually ulcerating their way inwards, at last dropped into the cavity of the intestine, being discharged *per anum*, and

leaving a firm cicatrix at the point to which they had been applied. For these various reasons, Guthrie, Travers, and other Surgeons of experience, advocate the practice of stitching up a wound in a protruding intestine in suitable cases, with which opinion I entirely agree. It is, however, evident that no positive and unvarying rule can be laid down that is applicable to all cases. Much must depend on the nature, cause, and extent of the wound in the gut. If it be very large and transverse, the result of gun-shot violence or other contusing force, no suture can be of any service; for, not only might it be difficult to bring the edges together, but they would probably not adhere to one another, nor to the abdominal wall. If, however, the wound be punctured or incised and of moderate extent, the case is different. Much will also depend upon the way in which the sutures are applied. They should be introduced by means of a fine round needle, armed with sewing silk, in such a way that the peritoneal surfaces on each side of the wound are brought into contact: adhesion takes place solely between these, the wound in the other structures of the gut filling up by plastic deposit. It has been recommended that the needle should penetrate the peritoneal and areolar coats only, no muscular tissue being taken up in it, lest retraction of the included fibres, by dragging upon the stitches, might re-open the wound. This advice, however, it is extremely difficult to follow. The safer plan is doubtless to carry the suture through the whole thickness of the gut, bringing the stitches out at about one-sixth of an inch from the edge of the cut, in such a way that the serous surfaces are drawn into apposition. The kind of suture that should be used is here represented (Fig. 261). When the lips of the wound have been nearly brought into apposition in this way, it has been proposed to leave the end of the thread hanging out of the aperture of the abdominal wall, and to withdraw it when it becomes loose; but I think it better not to leave it, as it might induce great irritation, acting like a seton in the peritoneal cavity. The ends, therefore, should be cut short close to the knot, when the suture will eventually become covered with lymph, and find its way into the inside of the gut by ulcerating through the muscular and mucous coats.

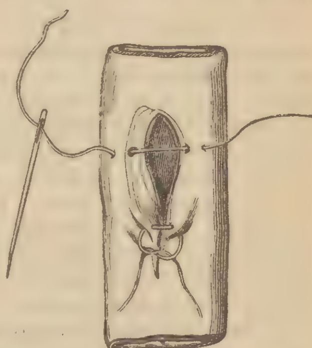


Fig. 261.—Applicaton of Suture to Wounded Bowel.

Should the aperture in it admit of being thus closed, the protruded portion of the intestine must be reduced, having previously been properly cleansed with a little lukewarm water. Should, however, the protruded gut be too extensively torn, and especially if it be lacerated by gun-shot injury, it would be useless to stitch it up, and it must be gently and carefully reduced. The reduction must be effected in the way that has been already described, the Surgeon being especially careful not to push the wounded coil of intestine far into the abdomen, but to leave it close to the external orifice, so that, in the event of extravasation occurring, or the stitches giving way, a ready outlet may be afforded. Should the wound in the abdominal wall be extensive, it must be closed by sutures and plasters, supported by a bandage, the inferior angle being left open to allow the escape of extravasation. The wound in the peritoneum had better be left; but should it be very extensive recourse

might be had to the practice that was successfully adopted in such circumstances by Ward, of stitching up the aperture in this membrane.

The after-treatment must be conducted in all respects on the same principles as in the case of an intestine wounded without protruding. Care must be taken, by attention to the position of the patient, and by the free administration of opium, to keep the bowel as quiet as possible near the external opening; the urine should be drawn off twice in the twenty-four hours, and no purgative whatever administered, lest by the excitation of peristaltic action adhesion be disturbed, and extravasation take place. After the lapse of six or eight days an enema may be thrown up, and repeated from time to time. No food should be allowed for the first three days, during which time ice and barley-water should be freely taken; after this, beef-tea, and light food that leaves no solid residue, may be given. It is of great importance that no solid food should be administered for at least two or three weeks after the occurrence of the injury. In a case of wound of the intestine which was under my care, the patient, who was progressing very favorably, and eventually recovered, nearly lost her life by eating the pulp of an orange on the tenth day.

Traumatic Peritonitis is the great danger to be apprehended in all serious injuries of the abdomen, and it is by inducing this that extravasation of fæces or of blood so frequently proves fatal. It is true that a certain degree of inflammation of the peritoneum is necessary for the healing of all abdominal wounds, but it must be limited in extent and plastic in character. It is the more diffuse form of peritonitis, attended by the exudation of turbid serum and shreddy ill-conditioned lymph, that is so speedily fatal. In these cases, we meet with the ordinary symptoms of the idiopathic form of this affection; uniform tenderness about the abdomen, but more particularly in the neighborhood of the injury, with occasional stabbing pains, followed by tympanitic distension, vomiting and hiccup, a small, quick, hard pulse, often assuming a wiry incompressible character, with considerable pyrexia, and great anxiety of countenance. This diffuse traumatic peritonitis will set in and run its course with great rapidity. In a case in University Hospital, already alluded to, of bullet-wound of the abdomen, the patient lived twenty-four hours. Two or three pints of serous effusion with much puro-plastic matter were found; and great reddening of the whole of the visceral and much of the parietal peritoneum had ensued. In another case of rupture of the ileum, the consecutive peritonitis proved fatal in about thirty hours after the accident. This extreme rapidity in its course and fatal termination, distinguishes traumatic from idiopathic peritonitis. To what is the rapid fatality of traumatic peritonitis due? It does not, as in the case of traumatic inflammations of the head and chest, cause death by the direct interference with organs, the healthy performance of whose action is directly essential to the continuance of life. It is also far more rapidly fatal than any inflammation of the pleura, pericardium, or arachnoid. May it not be due to some direct impression upon the sympathetic ganglia—to the collapse of nervous shock, associated with and intensified by an acute contiguous inflammation? In some cases the disease assumes a more chronic form; and recovery occasionally takes place. In the less acute forms of the disease, where life is prolonged for many days or several weeks, effusion of dark or turbid serous fluid takes place in the peritoneal cavity. As this effusion increases, dulness on percussion will manifest itself—usually first on the flanks, and then gradually extending forward until it may occupy a great extent of surface in the abdomen.

In the *Treatment* of this disease, we must be guided by the character of the inflammation. If it be sthenic, and the patient young and robust, he may be bled in the arm, but should certainly have leeches abundantly applied over the surface of the abdomen; a pill, composed of two grains of calomel and one grain of opium, may then be administered every sixth hour, or oftener if the patient be not influenced by the narcotic; and rigid abstinence from food should be enforced, ice and barley-water alone being allowed. If the peritonitis be the result of a wounded intestine, it is safer to omit the calomel, using instead mercurials to the inside of the thighs, but giving opium freely. When the peritonitis occurs in an old or feeble subject, our principal trust must be in the administration of opium and in free leeching of the abdomen, followed perhaps by a blister, which may be dressed with mercurial ointment. In these cases, however, early support will be required, with perhaps the administration of wine or stimulants. The inflammatory extravasation will gradually be absorbed under the influence of the calomel, aided by blisters.

INJURIES OF THE PELVIC VISCERA.

BLADDER.—**Rupture of the Bladder,** from blows upon the abdomen, is not of very unfrequent occurrence. It can scarcely happen when the organ is empty, as it then sinks down under cover of the pelvic bones. But when the bladder is greatly distended, rising high above the pubes, and thinned proportionately to its extension, it may very readily be ruptured, even by very slight degrees of external violence, as by one man rolling over another in a drunken scuffle, or by a person running against a post, or falling out of bed.

The *Effects* of this injury vary considerably, according to the part that has given way or been wounded. If the laceration have occurred in those portions of the viscus that are invested by peritoneum, the urine will at once escape into the pelvic and abdominal cavities, and speedily occasion death by intense irritation and inflammation. I have, however, seen a case in which, even in these circumstances, the patient survived ten days. If, on the other hand, that portion of the organ have been ruptured which is uncovered by the peritoneum, the urine may infiltrate into the areolar tissue between this membrane and the abdominal wall, and, diffusing itself widely, produce destructive sloughing of the tissues amongst which it spreads. In these cases life may be prolonged for some days, when the patient commonly sinks from the irritation and inflammation combined. An open wound of the bladder is by no means so dangerous as a subcutaneous rupture. Many patients have recovered whose bladders have been perforated and traversed by bullets, the urine finding a free exit through the apertures, and consequently not tending to extravasate itself. Guthrie relates several cases of this kind; and Thomson saw fourteen cases after the battle of Waterloo, in a fair way of recovery. Thus, although we may look upon this accident as of the gravest character, yet it cannot be considered as being necessarily fatal.

Symptoms.—The situation of the injury in the hypogastric region, the supervention of collapse followed by intense burning pain in the abdomen and pelvis, with inability to pass the urine, or, if any have escaped from the urethra, its being tinged with blood, are usually sufficient to point to the nature of the accident. If, in addition, it be found on introducing a catheter that the bladder is contracted and empty, or that but a small quantity of bloody urine escapes, the Surgeon may be

sure that this organ has been burst. In the case of gun-shot injury, the escape of urine which generally takes place through the track of the bullet will afford incontestable evidence of the mischief that has been produced.

When the bladder is ruptured through that portion which is covered by peritoneum, the urine escapes into the pelvic cavity; there, however, it does not diffuse itself, but remains like a feculent extravasation in the neighborhood of the aperture of the escape, restrained by the general pressure of the abdominal and pelvic viscera. This localized extra-vesical extravasation may be emptied by the catheter through the rent in the bladder, hence the escape of urine is not incompatible with rupture of the bladder. This important practical point is well illustrated by the following case. A man was admitted into the hospital under my care, who had sustained rupture of the upper and posterior wall of the bladder by falling down stairs; when admitted he was profoundly collapsed and semi-unconscious. The abdomen was swollen, tender, tympanitic in front, dull in the flanks. On passing a catheter the bladder was found to be empty and contracted, but with a little gentle manipulation the point of the instrument could be passed through the laceration in the posterior wall of the bladder, and a large quantity of clear urine was drawn off. For two days the patient seemed to be doing well. The catheter was taken out to be cleaned, could not be introduced afterwards, little urine escaped, and the patient died of peritonitis.

In the *Treatment*, the most important indication is the prevention of further extravasation by the introduction of a full-sized elastic catheter into the bladder. This must be tied in, and should be left open, with a vulcanised India-rubber tube attached, so that the urine may dribble away through it as fast as it accumulates. Opium should be given, as in all severe abdominal injuries, to prevent peristaltic action, and to prevent the diffusion of the urine through the abdominal cavity. If the rupture has taken place in a part of the bladder uncovered by peritoneum, the danger is from urinary infiltration. If any sign of extravasation appear externally, free and deep incisions should be made into the part so as to facilitate the early escape of the effused fluid and the putrid sloughs. I cannot but consider all active anti-phlogistic treatment as out of place in these injuries, never having seen the slightest benefit follow its employment. The only chance that the patient has, if once extensive extravasation have occurred, is that there may be sufficient power left in the constitution to throw out a barrier of lymph that will limit the diffuse and sloughing inflammatory action set up; and the prospect of this would certainly not be increased by the employment of depletory measures. There will also be so great a call upon the powers of the system at a later period, after sloughing has fairly set in, that a supporting or even stimulating plan of treatment will rather be required.

Foreign Bodies, such as pieces of catheters, tobacco-pipes, pencils, &c., are occasionally met with in the male urinary organs, having been introduced through the urethra. In some cases they are soon spontaneously expelled. If left in the bladder they become incrusted with phosphates, and thus become the nuclei often of large and irregularly shaped calculi; hence it is absolutely necessary to remove them speedily. This may occasionally be done by fortunately seizing the foreign body with a small lithotrite or urethral forceps at one end, and withdrawing it in the direction of its long axis. But if this procedure be unsuccess-

ful, it must be cut out. This is more safely done by the median than by the lateral operation of cystotomy.

Bullets, pieces of clothing, &c., are occasionally lodged in the bladder in gun-shot wounds of that organ. These speedily become incrusted with urinary deposits, and, giving rise to the symptoms of stone in the bladder, require to be removed by cystotomy, an operation that has proved very successful in these cases, evidently in consequence of the healthy condition of the urinary organs. Dixon has collected from various works the detail of fifteen cases, in which balls, that had either primarily entered the bladder, or had found their way into this organ by abscess or ulceration after having been lodged in the neighborhood, were extracted by operation. In ten of these cases the result was successful; in the remaining five no record is made of the termination.

Arrow-heads have also been met with in the bladder. There is, in the Army Medical Museum at Washington, a remarkable specimen of an Indian arrow-head which has formed the nucleus of a large phosphatic calculus.

In the female also, various foreign bodies are occasionally passed up the urethra, and slipping from the fingers are lost in the bladder. Hair-pins, bougies, pen-holders, and a vast variety of similar objects have here been met with. They may usually easily be extracted through the urethra, which should be expanded by a proper dilator.

Rupture of the Ureter.—Stanley has related a remarkable case in which the **Ureter** was ruptured by external violence, and in which the patient recovered; a very large accumulation of fluid forming on the injured side of the abdomen, with considerable circumscribed tumefaction and fluctuation, and which required repeated tapping. In another case, in which the **Pelvis of the Kidney** was ruptured, a similar collection of urine took place within the abdomen, requiring tapping; as much as six pints being removed at one sitting. On examination after death, which occurred in the tenth week from the accident, a large cyst was found behind the peritoneum, communicating with the pelvis of the kidney.

Wounds of the Organs of Generation in the male may be accidental, occasioned by sharp instruments or gun-shot, or may be self-inflicted. When only involving the integuments, they present nothing peculiar and do not differ from similar wounds in other situations, except in the great reparative power that the scrotal and penile coverings possess. Even when the whole of the skin of the part has been cut or torn away, the organ speedily recovers itself. In one curious case under my care, in which a woman had unsuccessfully attempted to cut off a man's penis with a carving-knife, the organ, which had had the whole of its integuments torn off from the root forwards, quickly covered itself with a new integument, which speedily assumed the soft and supple character natural to the skin of these parts.

When the penis is more deeply wounded, there are two special sources of danger, viz., hæmorrhage, and wound of the urethra. The hæmorrhage is usually very profuse. If it proceed from a distinct arterial trunk, such as the dorsal artery or that of a corpus cavernosum, the vessel must be ligatured. If it occur from general oozing from the vascular tissues of the penis, it may be arrested by cold, pressure, or astringents. Pressure is best applied by passing a large catheter into the bladder, and then compressing the organ against this by means of a narrow bandage or circular strip of plaster.

Injury of the genital organs by self-mutilation in cases of sexual

mania or melancholia is occasionally met with. In some cases the patient has cut off one testis; in others, the penis; in others, again, the whole of the external sexual organs. Injuries such as these present no very special character, and require to be treated on ordinary principles, the great point being of course to restrain the hæmorrhage and to prevent contraction of the urethral orifice.

URETHRA.—**Wounding of the Urethra** by gun-shot injury, or sharp instruments, is a troublesome accident, on account of the liability to the infiltration of urine and ultimately to fistula. It may be recognized by the escape of blood from the meatus, and of urine from the wound. The *Treatment* consists in the introduction of a gum catheter, which should be tied in; and if the edges of the wound be clean cut, they may be brought together by interrupted sutures.

Laceration of the Urethra is immediately attended by most serious symptoms, and remotely followed by most disastrous consequences. It very frequently occurs in men employed in building, from slipping in walking across an unfinished floor, in such a way as to fall heavily astride upon one of the joists, thus bruising the perinæum and rupturing the urethra and other structures lying under the rami and symphysis of the os pubis. The same accident may arise in other ways. Thus I have met with it in a farrier, kicked in the perinæum whilst shoeing a horse; and it has been met with as a consequence of laceration by a splinter of bone from a fracture of a ramus of the os pubis.

In these injuries the integuments are usually untorn, but deeply ecchymosed. The extravasation of blood is often considerable, extending into the scrotum, which rapidly swells up and becomes black. It may, indeed, be very serious, arising in some cases from the lacerated structures and the torn superficial or transverse arteries of the perinæum; in other instances from the corpus spongiosum, the bulb, or the artery of the bulb. In all cases of lacerated urethra, blood will drip from the orifice; and, if the bulb and its arteries have been torn, the hæmorrhage from these may be very great, a pint or more of blood being thus rapidly lost, in addition to great accumulations in the perinæum and scrotum, distending these parts with coagula and infiltration.

In consequence of the interruption in the continuity of the canal and the compression or plugging of the torn part by the coagula of the extravasated blood, the urine cannot be voided and the bladder gradually fills. If the patient attempt to empty it, only a few drops will issue from the urethral orifice; but he will be seized with severe burning, smarting pain in the perinæum, and the ultimate evils of the injury will be greatly aggravated, for, wherever the urine penetrates, sloughing of areolar tissue will invariably and rapidly ensue. There is this great difference between extravasation of urine from ruptured bladder and from lacerated urethra: in the first case the urine escapes involuntarily from the injured organ; in the second instance, no urine will escape from the torn urethra, unless by a voluntary expulsive effort on the part of the patient. The sufferings of the patient speedily become aggravated by the retention of the urine and the distress occasioned by the distension of the bladder; and the necessity for relief thus becomes urgent, lest by an involuntary spasmodic effort the urine be pumped widely into the already broken down areolar tissue of the perinæum and scrotum.

The ultimate results of a lacerated urethra are no less serious than the immediate effects. If the floor only of the urethra have been lacerated, leaving the upper part of the wall of the canal intact, the continuity of the urethra will not be lost, but a permanent traumatic stricture

of the worst kind will ensue. If the urethra have been completely torn across, or slough as a result of the injury, obliteration of a portion of the canal may take place, and an incurable urinary fistula will be left in the perinæum.

The *Treatment* consists in the early introduction of a catheter into the bladder. If this can be done before the patient has made an attempt to pass his urine, much of the immediate danger of the case may be averted, by the prevention of urinary infiltration. The catheter, which should be an elastic one, must be left in the bladder for a few days. It should not be plugged, but should have a vulcanised India-rubber tube attached, so that the urine may escape as fast as secreted. If any hardness, throbbing, or other signs of irritation occur in the perinæum, free incision should be made into the part, so as to afford a ready outlet for any urine that may have been effused. If the Surgeon find it impossible to introduce a catheter into the bladder, the urethra being torn completely across, he should pass it as far as it will go, and then putting the patient in the position for lithotomy, make a free incision in the mesial line upon the point of the instrument, so as to make an opening in the perinæum that will communicate with the deeper portion of the urethra; any arteries that bleed freely should be tied. He must then endeavor to pass the catheter into the bladder, through the proximal portion of the injured urethra. This is often extremely difficult. If the floor of the urethra only have been torn, it may be accomplished by keeping the point of the catheter well against the upper wall of the canal; but if the urethra have been completely torn across, it will tax all the skill of the Surgeon to direct and pass the instrument into the vesical end of the canal. An ingenious plan for overcoming the difficulty in such cases was suggested by T. P. Teale (senior), of Leeds. A director is first introduced into the proximal end of the opening in the urethra, and over it a dilator is passed; the director being then withdrawn, the catheter is readily introduced through the dilator. Should the urine become extravasated, the Surgeon must follow its course with free and deep incisions, supporting the strength of the patient at the same time by a due allowance of stimulants and nourishment. If, when the urethra is completely torn across, a catheter cannot be passed, and the urine finds a difficulty in escaping, relief not being afforded by the perinæal incision, and the bladder becoming over-distended, this organ should be tapped through the rectum, in the way that will be described when we come to speak of diseases of the urinary organs. But tapping through the rectum should not be done before the perinæal incision is made.

Vagina and Rectum.—**Foreign Bodies** are occasionally thrust forcibly into or impacted in the vagina or rectum. When a foreign body, such as a stick, or broom-handle, or the leg of a chair, is thrust forcibly up the rectum by a person falling on such a body, two dangers may result; either extensive laceration of the sphincter ani and the perinæum, with hæmorrhage; or transfixion of the gut and wound of the peritoneum, with consecutive inflammation of that membrane. The consequences of such an injury present nothing very special, and require to be treated on ordinary principles. If in the fall the foreign body have been forcibly thrust into the vagina, there will be danger of injury to the bladder or peritoneum; but the chief danger will result from laceration of the labium, and free hæmorrhage from this source. I have several times seen enormous quantities of blood thus lost. This hæm-

orrhage is best arrested by plugging firmly with lint soaked in a solution of the perchloride of iron, and by the pressure of a bandage.

A variety of things, such as pieces of stick, glass-bottles, gallipots, tumblers, &c., have been introduced and impacted in these canals. Their extraction is often very difficult, in consequence of the swelling of the mucous membrane over and around them, and the depth to which they have been pushed. In order to remove them, the use of lithotomy or necrosis forceps may be required. In some cases the foreign body produces ulceration into the bladder; and it has been found to transfix the wall of the canal in which it is lodged, and, by penetrating the peritoneum, has speedily occasioned death. A remarkable case of this kind occurred in my practice, in which a cedar pencil, five inches long, and cut to a point, had been forced up by the patient herself, a young woman, through the posterior wall of the vagina into the abdominal cavity. Here it transfixed two coils of the small intestine, and after being fixed there for eight months, I extracted it by an incision through the anterior abdominal wall, midway between the umbilicus and Poupart's ligament, where its point was engaged in the fascia transversalis. It had occasioned repeated attacks of peritonitis; and, after extraction, death resulted from that cause.

Laceration of the Perinæum.—The perinæum is occasionally ruptured during parturition. The extent of the laceration varies greatly, and influences materially the ultimate issue of the case. In some cases there is merely a slight rent at the fourchette; in others, the whole perinæum has given way as far as the sphincter ani; in a third case the sphincter is also torn; and in a fourth the rent has extended into the recto-vaginal septum. The worst cases are those in which the perinæum has been torn, and the recto-vaginal septum destroyed by sloughing from prolonged impaction of the fœtal head. In such cases, the loss of soft tissues and the existence of dense cicatricial bands render complete union by operation very uncertain.

The length of time that has elapsed since the occurrence of the injury is of little consequence. It is as easy to repair a perinæum that has been lacerated for ten years, as for ten days. A very serious evil arising from ruptured perinæum is the loss of support to the pelvic viscera, and the consequent liability to prolapsus of the uterus or of the vaginal or vesical wall. When the sphincter ani or the recto-vaginal septum has given way, incontinence of fæces to a greater or lesser extent is the consequence, feculent matter coming away in a fluid state involuntarily. The neighboring parts are from this cause liable to excoriation; and not unfrequently the rectal mucous membrane becomes prolapsed or hæmorrhoidal.

The *Treatment* which is purely operative, consists, in chronic cases, of a plastic procedure, having for its object the bringing together and the union by adhesion of the opposite sides of the rent. The extent and difficulty of this operation will vary according to the extent of the laceration, and its prospect of success will depend on attention to several points in its performance; but also, as in the case with most plastic procedures, on the state of the patient's health. This should be brought up to the best possible condition before the Surgeon proceeds to operate. All local irritation should be removed, piles of prolapsus ani cured, and the parts brought into as healthy a state as possible.

When the laceration is of very limited extent and recent, union may usually be effected by the immediate introduction of a point or two of suture, and bringing and keeping the thighs together. Should the lace-

ration, though it involves the whole perinæum, be confined to this, and not extend into the sphincter ani, it may usually readily be repaired by paring the edges freely, and passing two deep quilled and four superficial sutures, so as to bring the opposite sides together, as will immediately be described. After the operation, the patient should lie on her side, and either have the urine drawn off three times a day, or wear an elastic catheter for at least a week. In these cases the bowels may be allowed to act naturally, care being taken that the motions be kept away from the perinæum, which must be supported by the nurse when the bowels act.

When the laceration is very extensive, extending through the perinæum, the sphincter ani, and the posterior wall of the vagina into the rectum—in fact, tearing through the recto-vaginal septum—more extensive and most careful treatment will be required. The following is the mode of performing the necessary operation.

Operation for Rupture of the Perinæum involving the Recto-Vaginal Septum.—The bowels having been well cleared out, the patient should be placed in the position for lithotomy. The upper wall of the vagina being held out of the way by means of a "duck-billed" speculum, the edges and sides of the rent must be freely and deeply pared in a horse-shoe shape, so as to leave a raw surface about an inch in width. The greatest care must be taken to remove every particle of mucous membrane and integumental structure, not only from the side of the fissure, but also from above the upper angle of it, in the recto-vaginal septum, and from the anterior part of this. Any portion of these structures that may be left behind, however minute, will, of course, be an obstacle to union, and will either interfere completely with it, or leave a fistulous opening in its site. The sphincter ani should then be freely divided on each side of the coccyx, as recommended by Brown, in order that its action may be paralysed, and all tension of the part removed; or, what is better, the muscles around the anus may be loosened by subcutaneous section of their coccygeal attachments. Three quilled sutures (Fig. 262) should then be passed deeply through the freshened side of the laceration, and the edges brought together by a few superfine interrupted sutures, or by a continuous suture. The deep sutures are best introduced by long nævus needles. The one nearest the anus should be passed first; and if the recto-vaginal septum be involved in the rent, it must be dipped into but not passed through the freshened surface of this part, so as to draw it well forwards and against the new perinæum. The sutures should be introduced at a distance of one inch from the cut edge, should pass about three-quarters of an inch in depth, and be brought out on the other side at the same distance from the freshened surfaces as that at which they entered. The great difficulty in this operation will be found to consist in the enlargement of the aperture in the recto-vaginal septum, and in bringing its edges together. In proportion to the loss of substance that has occurred, this difficulty will increase. Sometimes a narrow band, the result of some previous ineffectual attempt at union,

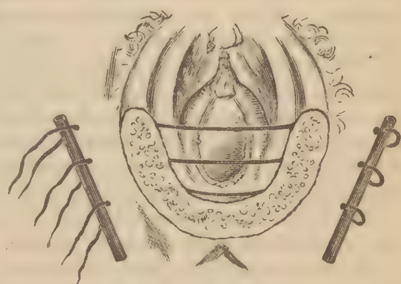


Fig. 262.—Operation for Lacerated Perinæum.

will be found to stretch across the gap at the verge of the anus. This should not be retained, as it will be greatly in the way of the operator, and useless as far as after-union is concerned.

The best material for the deep sutures is strong whip-cord well waxed, or iron wire. I now generally prefer the wire as less irritating. For the superficial sutures, thin annealed silver wire should be applied in the continuous manner by means of the glover's stitch; the parts are thus much more securely and easily held together than by the interrupted suture.

The success of the operation will, to a great extent, depend on the attention bestowed on the *after-treatment*, the mode of conducting which has been laid down with much precision by B. Brown. The principal points to be attended to are as follows. Immediately after the operation, a full dose of opium should be given, followed by a grain once or twice a day, so as to arrest all intestinal action. The patient should be laid on her side, and a catheter, furnished with a long India-rubber tube introduced, retained so as to prevent any dribbling of urine over the raw edges, which would be fatal to their union. The hæmorrhage usually ceases when the edges are brought together. If it should continue, the application of a pad and T-bandage, and of ice in the vagina, will generally easily control it. The deep sutures, if of whip-cord, should be left in for three days, as a general rule. In some cases they may even be retained for four days; but if any suppuration be set up along their track, they must at once be withdrawn; if of wire, they may be left longer—for six days. The superficial sutures should be left in as long as they produce no irritation; when of silver wire, they may be left undisturbed for eight or ten days. During this period, I have found it advantageous to keep the part covered with collodion. When the sutures are removed, a pad of dry lint, supported by a T-bandage, should be applied. When the recto-vaginal septum has been implicated, the bowels should not be allowed to act for at least ten or twelve days, lest the freshly united surfaces be torn through. When the perinæum only has been the seat of laceration, they may be allowed to act earlier. During the whole of the treatment, the patient's strength must be supported by abundant nourishment, and scrupulous attention paid to the cleanliness of the parts, which should be frequently syringed with carbolised water and covered with finely carded dry wool.

Plastic operations of this kind should not be performed unless the patient be in a good state of health, that there may be a good prospect of immediate union. The success of the case will at last mainly depend on the extent of laceration, or rather of loss of substance, in the recto-vaginal septum. If this be uninjured, or merely notched as it were, there will be but little difficulty experienced in effecting a cure. If, on the other hand, this wall be deeply lacerated, or, still worse, if a portion of it have sloughed away, the greatest difficulty may result in effecting union; and in such untoward circumstances it may happen, that the perinæum unites, but that a fistulous opening is still left in the recto-vaginal wall, requiring a future plastic operation for its closure (*vide* Chapter LXVI.).

DIVISION THIRD.

SURGICAL DISEASES.

DISEASES AFFECTING THE TISSUES GENERALLY.

CHAPTER XXX.

MORTIFICATION, OR GANGRENE.

THE death of a part of the body only is, in surgical language, termed **Mortification** or **Gangrene**. When the morbid action is confined to the osseous structures or to the cartilages, it is termed **Necrosis**; when limited to the soft tissues of a limb, **Sphacelation**; and when accompanied by ulceration, it is called **Sloughing**. Many other varieties of gangrene are recognised by Surgeons. Like all other diseases, it may be **Acute** or **Chronic** in its duration; as the parts affected are moist and swollen, or dry and shrivelled, it may be divided into the **Moist** and the **Dry** or **Mummified** gangrene; so again, according to its cause, it is spoken of as **Idiopathic** or **Traumatic**; and very frequently, and most correctly perhaps, it is arranged under the denominations of **Constitutional** and **Local**. Besides these, various **Specific** forms of the disease are met with, which will require special consideration.

LOCAL SIGNS.—Whatever form the gangrene may assume, certain local phenomena are common to all varieties. The part becomes colder than natural; not only is it colder than the corresponding part on the opposite of the body, but the temperature may fall below that of the external air. The sensibility of the part is lost. It may be touched, pricked, or cut without feeling. In some cases the sensibility is greatly increased just before gangrene sets in, intense agonising pain of a burning or neuralgic character being experienced, which soon gives way to complete insensibility. All motion of the part itself ceases. It may be moved by muscles from a distance, as a mortified toe might be moved by unaffected flexors or extensors, but it has no power of motion independently of that which is communicated from a distance. The skin of the mortified part becomes discolored, usually greyish or greenish, the cuticle separates, and when pressed upon obliquely slides away under the finger, leaving the moist and slippery cutis exposed. The color gradually darkens to a dull purplish greenish black, mottled in patches with reddish-brown spots, and after a time there is an odor of putrescence evolved, very commonly with an emphysematous crackling from effusion of gas into the tissues of the part. The color of the part affected is usually of a

dark purplish or greenish black, more or less mottled with red. This, which is unlike anything else in the system, shows that putrefactive changes have taken place in the solids and fluids of the diseased tissues, and is usually connected with the *moist* and swollen form of the disease. In the *dry* variety of gangrene the color is often at first of a pale tallow-white, with a mottled appearance upon the surface. The skin soon shrivels, becomes dry, horny, and semi-transparent, and eventually assumes a brown wrinkled appearance; in other cases the gangrenous part is brown, dry, and shrivelled from the very first. These differences in the color of the mortified part indicate corresponding differences in the cause of the affection. In general terms, it may be stated that the dark varieties of gangrene are the result of destructive changes taking place in the very part itself, or are of constitutional origin; whilst the pale form of the affection occurs as a consequence of some obstruction to the supply of blood to the part, and is a local disease, influencing the constitution secondarily. But it must be borne in mind that gangrene may occur, that is to say that the part may lose its vitality, without becoming dark, fœtid, or emphysematous. These signs, though sometimes contemporaneous with loss of vitality, are more frequently consecutive to it, and indicate more than the simple death of the part; they are proofs of putrescence having set in, as well as of death having occurred.

Constitutional Symptoms.—These vary greatly. When the disease is strictly local, affecting a part of but limited extent, and perhaps of no great importance to the economy, they are not very strongly marked. If, however, the gangrene, although limited, implicate important organs, as a knuckle of intestine for example, marked symptoms declare themselves. Whatever the precursory condition may be, the full invasion of the gangrene, if it be rapid, is always accompanied by constitutional disturbance of an asthenic type, attended by great depression of the powers of the system, with a dull and anxious countenance, and a feeble, quick, and easily compressible pulse; the tongue is brown, and soon becomes loaded with sordes. When the gangrene is internal, sudden cessation of pain, with hiccup, vomiting, and tympanitic distension of the abdomen, may be superadded to the symptoms, and indicate the mischief that has occurred. Death usually supervenes with low delirium, twitchings, and coma. When the invasion of the gangrene is more gradual, as in some of the constitutional forms affecting the lower extremities, the symptoms are usually those of irritative fever, eventually subsiding into the asthenic form.

Causes.—The causes of gangrene are various. They may be arranged under four principal heads.

1. **Traumatic Causes** of various kinds, acting immediately on the part, give rise to different forms of gangrene. Thus, gangrene of a part may be produced when the vitality of its tissues is destroyed by severe contusion or laceration; or by an irritating fluid; or by exposure to intense heat or cold.

2. **Arrest of the Supply of Arterial Blood to a part** is a common cause of gangrene. It may be produced by accident, or by ligature or other surgical operation, or by calcification or embolism of the arteries.

3. **Obstruction of the Circulation through or Retardation in the return of Venous Blood from a part** may cause gangrene. Under this head are to be classed those forms of gangrene which arise from inflammation, and those in which the return of blood through the

principal veins is interfered with by thrombosis, or by pressure on the venous tract.

4. **Specific Poisons** of various kinds occasion special diseases of which gangrene is the principal characteristic. Thus, hospital gangrene, malignant pustule, glanders, cancrum oris, carbuncle, and ergotism, are instances of specific affections accompanied by gangrenous action.

Amongst the causes, some are **Constitutional**, others **Local**, in their action. Those forms of gangrene are said to be *constitutional* which arise from intense or specific inflammation of the part; from obstruction of the circulation in consequence of disease of the heart and vessels; or from the action of various specific poisons. On the other hand, those varieties of gangrene are *local* which arise from injuries of all kinds, whether applied to the part itself, or to the main artery leading to it, by its ligature or wound, or from the plugging of the vessels which communicate with ulcers or other circumscribed inflammation.

These forms of gangrene which arise from traumatic causes, have been already described in previous chapters (see pp. 224, 268, 276, 320); while those that arise from obstructed circulation to or through a part, or that take the form of specific disease, are left for consideration here.

Gangrene from Arrest of the Supply of Arterial Blood.—Whenever a part of the body is deprived of its proper supply of blood, mortification may ensue. Most commonly, when the principal trunk of an artery is obstructed, the collateral circulation is sufficient to maintain the vitality of the part; but, should this be interfered with, gangrene occurs from the simple deprivation of blood. Indeed, the sudden loss of a large quantity of blood from the system generally may occasion the death of some of the extreme parts of the body, in which the circulation is naturally most languid. Thus Sir B. Brodie relates the case of a drunken man, who, being bled to an inordinate extent, was seized with gangrene of both feet.

The want of a due supply of arterial blood to the limb may be occasioned by two primary sets of causes:—*a*, from *injury or operation*, as wound or ligature of the main trunk; *b*, from *disease*, as by *thrombosis* or by *embolism; by calcification, and subsequent occlusion of the vessel.* Gangrene from arterial obstruction varies materially in its symptoms, prognosis, and treatment, according as it arises from one or other of these causes. When the obstruction is seated in the arteries alone, the gangrene will be of the dry kind; but when there is also an impediment to the return of blood through the veins, the disease will partake more or less of the character of the moist variety.

a. A limb gangrenous in consequence of the **Ligature or Wound of its Main Artery**, without any other injury to the vascular system, becomes cold, feels heavy, and loses its sensibility; at the same time it assumes a dull tallowy-white color, mottled with greyish or brownish streaks. This state of things is chiefly met with in the lower extremity; the integuments of the foot die, becoming semi-transparent and horny-looking where they are stretched over the tendons of the instep, and the part presents a shrivelled appearance. In a short time the pallid color is lost, the part becoming brown or blackish. This form of gangrene may invade the whole of the lower limb, but most commonly is limited to the foot, stopping either just above the ankle, or if not there, immediately below the knee, as Guthrie has observed; the arrest taking place in one or other of these two spots, on account of the greater freedom of the collateral circulation here than in other parts of the limb. If any of the large venous trunks become obstructed or otherwise implicated, so that

the return of blood through them is interfered with at the same time that the supply by the arteries is arrested, the limb generally assumes a greenish-blue color, and rapidly runs into putrefaction. In some of these cases it happens that sloughs of the integument and subcutaneous areolar tissue form, although the limb generally preserves its vitality. The treatment of these forms of gangrene, which are strictly local, is described in the chapter on the Arrest of Arterial Hæmorrhage.

b. Gangrene may occur from the arrest of the circulation through an artery as the result of **Disease or Alteration in the Coats of the Vessel or from some Morbid State of the Blood.** This is the variety that is commonly called *Spontaneous.* It may be the result of thrombosis or embolism in a previously healthy artery, of the plugging up of an artery that has undergone atheromatous change, or calcification, or other senile degeneration.

Spontaneous gangrene from the formation of **Thrombosis**, or clot in an artery, usually occurs in young or middle-aged persons. Whether the thrombosis be the result of, or the antecedent to, inflammation within the vessel, is a question which need not be discussed here. In either case, when gangrene from this cause appears, we meet with the usual signs of arteritis, such as tenderness along the course of the vessel, cessation of pulsation in its terminal branches, and intense superficial pain in the limb, followed up by the rapid supervention of dark dry gangrene in the whole of the extremity up to the point at which the vessel is inflamed. In some cases the gangrene partakes of the characters of the humid form, owing to the implication of the continuous veins. It is, I believe, most frequently met with in the upper extremities; at least, most of the instances of it that I have seen have been situated there. I have observed it most commonly in women, occurring sometimes at an early period of life, even in the eighteenth year. Its causes are very obscure; in some cases the disease appears to be of rheumatic origin, in others it is connected with a cachectic and broken state of constitution. It frequently proves fatal by the supervention of typhoid symptoms, before any attempt can be made by nature to separate the mortified part. After death, the affected vessel is found firmly plugged at the seat of obstruction by a dense coagulum, which completely impedes the circulation through it.

Gangrene may also be produced by **Embolism**, the terminal branches of the arteries and the capillary vessels becoming plugged by a mass of finely granular fibrinous matter, which is carried away by the blood-current from the heart, or is washed down and into the lower part of the vessel from the inflamed patch on the inner surface of the artery at a higher point. In peculiar conditions of the blood, at present of an uncertain character, this plugging is more specially apt to occur. In some cases the embolon appears to consist of a plug of plastic matter which has been detached from a distant part of the circulatory apparatus, from the interior of the left ventricle for instance, and being carried by the circulation into the arterial system, stops at some point of bifurcation or of narrowing of a vessel. In such cases the gangrene may develop itself suddenly. The accompanying drawing (Fig. 263) represents the bifurcation of the common femoral artery occupied by a fibrinous plug, taken from a man aged 32, who died of gangrene of the left leg. In this case, the patient, after recovering

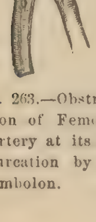


Fig. 263.—Obstruction of Femoral Artery at its Bifurcation by an Embolon.

from rheumatic endocarditis, whilst straining at stool, suddenly felt his left leg tingle painfully, then become numb and cold. The circulation in it ceased, and gangrene speedily supervened, which extended as high as the knee. Death followed amputation of the limb. Here there can be little doubt that the sudden supervention of gangrene was the result of obstruction to the arterial circulation of the lower extremity, consequent on the detachment of a fibrinous endocardial plug, and its arrest at the bifurcation of the femoral artery.

Spontaneous gangrene is termed **Senile** when it occurs in old people in consequence of the **Coats of the Arteries becoming Rigid and Calcified** (Fig. 264), and unable to maintain the proper circulation of blood through the limb. The want of a due supply of arterial blood in these cases is not only owing to the diseased state of the arteries, but is in a great measure due to the feeble propulsive power of the heart, and the consequent naturally weakened circulation through the lower limbs especially. When the circulation is so enfeebled as to lower the nutrition of the limb, coldness, cramps, and in some cases cutaneous ulcerations, will ensue. When the circulation becomes arrested from the conjoined influences of diminished cardiac propulsive power and arterial obstruction, gangrene inevitably results. It is met with in the lower extremities of people past the middle period of life, and the tendency to it increases as age advances. The premonitory symptoms are as follow. A sensation of weight in the limb, with coldness, itching, and tingling in the feet, and cramps in the calves, is complained of, and the circulation of the part is habitually defective, the pulsation of the tibials being scarcely perceptible. This condition commonly exists for a considerable length of time before gangrene actually comes on, and should always be looked upon with anxiety in old people. In many instances the disease sets in without any exciting cause; but in other cases the mortification is immediately developed, as the result of some slight inflammation accidentally induced, as from the excoriation produced by a tight boot, or from a trivial wound in cutting a corn or toe-nail; the inflammation occasioned by this slight injury being sufficient to disturb the balance of the circulation in the already weakened part to so great an extent, that gangrene ensues. In other instances, again, the disease is ushered in by more acute symptoms. The whole foot becomes swollen, œdematous, and red; inflammation, apparently of a gouty character, being set up in it. In whatever way it begins, the gangrene may at first only affect one toe, or it may from the commencement involve several toes. It most generally in the first instance appears in the form of a cold purple or blackish-red spot on the side of one of the toes, usually the inner side of the great toe; this spot may be surrounded by an inflamed areola, and accompanied by much smarting and burning pain of a paroxysmal character; it spreads by gradually involving the inflamed areola, which continues to extend in proportion as the gangrene progresses. The pain, which is often of the most intense character, subsides when the gangrene becomes complete.

Fig. 264.—Arteries of Lower Extremity obstructed in Senile Gangrene.

In other cases the toes and foot simply shrivel, without any sign of local inflammation and with but little constitutional disturbance. In one or other of these ways the affection gradually creeps up the limb, invading perhaps one toe after another, involving the instep (Fig. 265), the heel, or the sole of the foot; and unless it terminate by the formation of the line of demarcation, or death put an end to the patient's sufferings, it may extend up the ankle or leg. The part that is destroyed is always black, dry, and shrivelled, resembling closely in appearance a dried mummy; hence the change is often termed **Mummification** (Fig. 266). The toes often look like the shrivelled skins of over-ripe or sucked-out black grapes. There is usually considerable constitutional disturbance, sometimes pyrexial at first, but subsequently sinking into an irritative or asthenic form; and the disease is often fatal in from a month to six weeks. But this is very uncertain. I have known the disease to continue with very little constitutional disturbance for more than twelve months, slowly creeping on during that time. In other instances, the gangrene being limited to a small extent, as to the toes only, the patient may recover with the loss of the fore part of the foot. The pathology of the arterial system, in reference to these forms of gangrene, will be more fully discussed in the first chapter of Volume II.

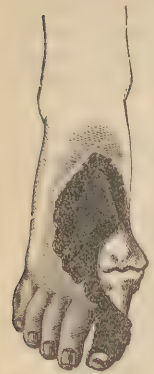


Fig. 265. — Senile Gangrene: Exposure of Bones of Foot.

GANGRENE FROM OBSTRUCTION OF THE CIRCULATION THROUGH OR FROM A PART.—This may occur in three ways: 1, by *Venous Obstruction*, and consequent over-accumulation of blood; 2, by the arrest of all the blood, arterial, venous, and capillary, as in *Strangulation* by a tight ligature; 3, by *Inflammation*.

1. **Venous Obstruction.**—Gangrene may arise from obstruction to the return of blood through the veins of a part, the circulation being arrested by the overloading of the capillaries with venous blood. It is especially apt to take place if the arterial supply be diminished at the same time that the return of venous blood is interfered with: as when an artery and vein are compressed, or when the femoral vein is wounded accidentally at the time when the artery is ligatured. Gangrene from this cause is always of the moist kind, attended by much œdema, with discoloration and rapid putrefaction of the part.

This gangrene from venous obstruction is also especially apt to occur in those cases in which the heart's action is weakened, so that the propulsive force in the arterial system is so lowered as to be unable to push the blood through the loaded veins. Those cases of gangrene of the extremities that are met with from pure debility, as after fevers, often appear to originate in this way.

2. **Strangulation.**—A part is often purposely strangled by a Surgeon in operative procedures; or its circulation may in this way be arrested as the result of certain accidents or diseased conditions. (See p. 204). In either case, the strangulation acts by stopping more or less completely the whole of the circulation through the part. If the strangulation be sufficiently severe, it may kill the tissue outright: for instance, when a nævus or a pile is tied, all flow of blood to or from the part is suddenly arrested, and its vitality is destroyed, the tissues that have been strangled shrivelling and separating by ulceration along the line of ligature. When the strangulation is not so severe as this, great

congestion ensues, consequent on the amount of blood sent into the part being greater than can be removed by the veins, which are more affected by the constricting force than the arteries; the part strangled becomes dark and congested, phlyctenæ or vesicles arise on its surface, and effusion takes place into its tissue; inflammation becomes at last superadded to the effects of the strangulation, and still more embarrasses the circulation of the part: and thus sloughing arises, from the conjoined action of the strangulation and the inflammatory exudation. All this we find in the constricted gut of a strangulated hernia.

3. **Inflammation.**—Deferring for the present the consideration of certain specific forms of inflammatory disease that are liable to be attended with gangrene, we have here to consider the death of parts, when it occurs as a sequence of ordinary inflammation. The production of gangrene by inflammation—or rather, perhaps, by the congestion forming part of it—is a less simple affair than its production in either of the ways which we have already described. Sir James Paget remarks that in certain forms of gangrene after inflammation, all the more simple ordinary causes of mortification may be involved along with others; thus, "1. The inflammatory congestion may end in stagnation of the blood; and this, as an indirect cause of mortification, may lead to the death of the blood and that of the tissues which require living circulating blood for their support. 2. A degeneration of the proper textures is a constant part of the inflammatory process; and this degeneration may itself proceed to death, while it is concurrent with defects in the conditions of nutrition. 3. The exudation of fluid in some inflamed parts may so compress, and by the swelling so elongate the blood-vessels, as to diminish materially the influx of fresh blood, even when little of that already in the part is stagnant."

The *intensity* of the inflammation may be so great as to kill the part directly, however healthy its texture or sound the constitution of the patient may be. More commonly, however, it is not so much the actual as the relative intensity of the inflammation that destroys the part; there being some debility, local or constitutional, by which the resisting or preservative power is lessened. Paget says that the gangrene here seems to arise especially in persons whose tissues have become degenerate in consequence of old age, of defective food or of other materials of life, or through habitual intemperance; the disturbance of local nutrition, which forms part of the inflammatory process, being greater than the enfeebled tissues can resist or overcome. It is remarkable to observe what slight injuries will induce gangrenous inflammation under these circumstances. The nature of the tissue exercises, however, considerable influence; thus, with a moderate amount of inflammation, some tissues very readily run into gangrene, the areolar membrane especially being apt to do so; whilst others, as the proper tissue of glands and organs, are seldom so affected.

The *specific character* of the inflammation influences greatly the disposition to gangrene; some forms, as the carbuncular, invariably resulting in the loss of vitality of the part. In some states of the constitution, the blood appearing to be diseased, there is a great liability to gangrene.

Gangrene consequent on inflammation is of the moist or acute kind, being always connected with a retention of blood in the part affected. We may regard it as impending in a part that has become inflamed from injury or other cause, if we find that the redness becomes of a dusky or purplish hue; that bullæ filled with dark fluid rise upon the surface;

that the swelling, at first hard, tense, and brawny, becomes of a pulpy or doughy character; that the pain is of a dull, heavy, or burning kind; and that the temperature of the part, at first greatly increased, gradually sinks. We know that gangrene has taken place when there is a total loss of the sensibility of the part, even to pricking or pinching; that the motion of the part itself ceases; that its color changes to a peculiar mottled, purplish-red, or greenish-black hue, unlike anything else in the body; that the temperature falls to a level with that of surrounding air; or that the surface affected may, by evaporation, even feel colder. There is likewise an odor evolved, differing from that of ordinary *post-mortem* decomposition, and evidently depending upon gaseous exhalations from the part that has lost its vitality, and has at the same time become, while retained in connection with the living parts, the seat of putrefactive changes. The extent of tissue affected may vary from a mere spot to the implication of the greater portion of a limb; and the gangrene appears to be finally arrested by the inflammation losing its force as it radiates from the centre, until it reaches a part where it is sufficiently reduced to be compatible with those processes of separation and repair which will be immediately described.

The *Constitutional Symptoms*, always of a low type, vary according to circumstances. If the blood be healthy, and the constitution sound, the gangrene occurring as the consequence of severe injury, the symptoms will present the ordinary character of inflammatory fever, though even in these cases there is a great tendency to asthenia. If the constitution be broken, or the blood in a diseased state, the constitutional symptoms will rapidly run into the irritative form.

Arrest of Gangrene.—Certain forms of gangrene (see p. 225) have a tendency to extend indefinitely until the patient succumbs to the disease. In many instances, however, the progress of the mortification is arrested, and the dead parts are separated from the living. When the gangrene reaches a part of which the vitality is too great to be destroyed by the operation of the causes which have produced death in the tissues beyond, **a line of demarcation** is formed. This line consists of a kind of barrier or septum of fibrinous or plastic matter, poured out into the interstices of the healthy tissues at their extreme limits next the gangrene; the line, indeed, along which the dead and living parts touch. It extends along the whole depth of the gangrene, completely surrounding it on all its attached sides. It appears to be formed exactly by the same process, and by the same mechanism, as that by which lymph is effused around any foreign body or fluid accumulation that has lost its vitality. Just as lymph forms the boundary wall to extravasation of blood, or to accumulation of pus in an abscess, so it forms a barrier, deposited in the living tissues, to separate them from the dead structures beyond, which by their loss of vitality have become foreign to the adjoining healthy structures. The inflammation, if any be present, is reduced in intensity at this part; it does not, however, cease abruptly, but fades away in the healthy structures beyond it.

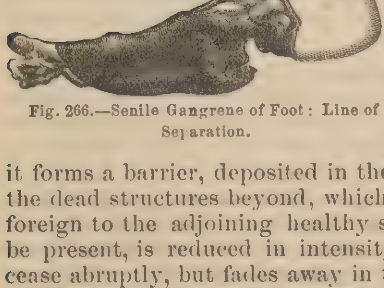


Fig. 266.—Senile Gangrene of Foot: Line of Separation.

When the gangrene is arrested, nature throws off the spoilt parts, not

by a process of disintegration or falling to pieces of these parts, but by a vital act—a process of ulceration, extending through the line of demarcation, and loosening the slough or necrosed tissue by the softening and absorption of that layer of living tissue which lies next to it. This line of ulceration is termed the **line of separation**, and extends itself along the extreme margin of the living tissues (Fig. 266).

This process of separation, commencing at the edge of the slough, which gradually loosens, slowly extends downwards to the whole depth of the gangrene; if this affect the entire thickness of the limb, the ulceration will find its way completely across it. If the slough be more superficial, the ulcerative action passes underneath it, and detaches it gradually. The line of separation is usually oblique, the soft parts being first divided, and the hard tissues then ulcerated through, until the ligamentous or osseous structures are reached, which are slowly acted upon. As the ulceration extends across the limb, the largest arteries and veins are cut through by it, without the occurrence of hæmorrhage, owing to a mass of plastic matter being poured out in their interior, and blocking them up from the line of separation to the nearest large collateral branch above it. The period required for the detachment of gangrenous parts varies according to their extent. Small sloughs may be detached in a few days, whilst many weeks are required for the separation of a limb. The action is most rapid in the soft vascular tissues and in young subjects.

After the separation of the gangrened part, a more or less ragged irregular ulcerated surface is left, which, if not too extensive, and the patient's reparative powers be in a favorable state, will undergo cicatrisation by the same process as in ordinary ulcers. This, indeed, commences while the separation is going on; granulations gradually appearing in that part of the line of separation which has effected its purpose of cutting off the dead from the living parts.

Diagnosis.—The diagnosis is easily effected when gangrene has fully developed itself; but in the early stages, before it is positively declared, it is not always easy to determine its existence. The ecchymosis and discoloration of a bruise, the collapse and lividity that result from cold, or the dark purple hue occasioned by long-continued congestion, may readily be confounded with impending gangrene. In these cases of doubt the Surgeon should not be in too great a hurry to pronounce an unfavorable opinion, and still less to act upon it; for not uncommonly parts of the body which have to all appearance lost their vitality, may, under proper treatment, regain it.

Prognosis.—So far as the part itself is concerned, the prognosis is always bad; though occasionally, when gangrene has not been fully established, partial recovery may unexpectedly take place. So far as the life of the patient is at stake, much will depend on the cause of the affection, and on the age and strength of the individual; at advanced periods of life, and in a feeble state of system, the result is always unfavorable. Also whilst the gangrene is spreading, the prognosis is bad, as it is impossible to say where the morbid action may stop; but when a "line of demarcation" has formed, indicating the possession of a certain vigor of constitution, the principal danger is over, and the result will depend on the power of the patient, and the support that can be given during the process of separation and of repair.

Treatment.—As gangrene proceeds from a great variety of causes, it is evident that no one plan of treatment can be universally applied; and it becomes necessary to modify our therapeutical and operative means,

not only according to the cause of the disease, but also with special reference to the constitution of the patient, and with regard to the stage in which we meet with the gangrene; and, indeed, it often requires great tact and experience to accommodate the treatment in this way to the varying phases of the disease.

The **Constitutional Treatment** of gangrene is of the highest importance; of greater moment, indeed, in the *spontaneous* forms of the affection than the local management of the disease. It has three principal aims: 1. To *remove the cause* if possible, and thus to *arrest the gangrene*. 2. To *support the powers of the system during the process of the separation of the sloughs and dead tissues;* and 3. To *lessen the irritability of the nervous system.*

1. In the *removal of the constitutional cause*, we must look wholly to the condition of the patient's system. If this be in an inflammatory or febrile state, we must have recourse to a modified antiphlogistic plan. Depressing remedies must be very sparingly used, the patient's condition being usually not of such a nature as to bear lowering. It is very easy to knock down inflammation by energetic measures; but, at the same time, the reparative power of the system may be destroyed, and the patient may not be able to rally. Inflammatory fever, however high it may be in the early stages, rapidly sinks after gangrene has set in, symptoms of an asthenic or an irritative type ensuing. Hence it is only before the occurrence and during the spread of gangrene, that lowering remedies can be employed; for, when once gangrene has ceased to extend, however high the action may have been that accompanied its progress, all the powers of the constitution will be required to maintain the process of separation of the sloughs, if they be extensive and deep. Venesection is never required in any form of gangrenous inflammation. An enfeebled state of the circulation of the part or the system generally may equally occasion or complicate the gangrene; and there may be every possible combination between this and an active inflammatory condition. In these circumstances, it will be necessary to conjoin an antiphlogistic form of treatment with remedies of a tonic, or even stimulating character. It is this plan of treatment that is commonly found to succeed best in spontaneous gangrene; here moderate antiphlogistic remedies are perhaps required in the earlier stages, with a light nutritious diet and mild tonics as the disease advances; and in the latter periods, when the constitutional symptoms become asthenic, stimulants should be given. The best stimulants are wine or porter, according to the patient's habits of life; and these should be given in combination with nourishment, so as not merely to raise the pulse, but to produce a more permanent tonic influence on the system generally. If much depression occur, the medicinal stimulants, especially ether, ammonia, and camphor, are of material service. The only tonics that are of much value here, are the preparations of cinchona bark and some of the vegetable bitters, as gentian and cascarilla; and though the specific virtues that were formerly attributed to them can no longer be accorded, yet when they do not irritate the stomach, they are of unquestionable service in combating the asthenic symptoms, and improving the digestive powers. In these cases I look upon cinchona bark, in combination with chlorate of potash and ammonia, as of undoubted value.

2. After the proper employment of means calculated to remove the constitutional cause of the gangrene, the *system must be supported against the debilitating influences that accompany the process of ulceration and of suppuration* necessary for the separation of the mortified

parts. During this period, there is less irritation but more debility, and stronger tonics and stimulants can be borne; but we should be careful not to overstimulate the patient. On this point it is extremely difficult to lay down any precise rule; every possible variety as to the quantity and quality of food and stimulus being required by different individuals. The safest guides are the state of the pulse and tongue; if they improve, the means employed agree. At the same time hygienic measures should be carefully attended to; cleanliness and free ventilation, with the abundant use of the disinfectants, are of the first moment, so that the patient may not be poisoned by his own exhalations.

3. The third indication, that of *lessening the irritability of the system* that always supervenes, and which is partly owing to the severity of the pain, and partly to the shaken and depressed state of the nervous system, is best carried out by the administration of opium; and although this drug may not act as a specific, as Pott supposed, yet in many cases and especially in the gangrene of the toes and feet of old people, it is undoubtedly a remedy of the greatest value. A grain of solid opium may be administered advantageously every sixth, eighth, or twelfth hour, according to the effect which it is found to produce; care being taken that the bowels do not become confined. The hiccup, which is often distressing, is best remedied by the administration of spirits of chloroform and camphor.

Local Treatment.—Gangrene, when threatening as the result of inflammation, may often be prevented by free incisions into the inflamed and tense tissues. Punctures are not sufficient, but free incisions two or three inches long should be made, which by gaping widely allow the escape of blood and other fluids, and thus effectually relieve the vessels and the tissues. This is more especially the case where there is much loose areolar tissue, as in the penis or scrotum; or indeed in any part in which much tension is conjoined with the inflammation. The *relief of local tension* is of the first importance in cases of inflammation threatening to terminate in gangrene. By a free incision through the structures so affected, as in phlegmonous erysipelas or carbuncle, not only may the vitality of the affected tissues be preserved, but the extension of gangrene, if it have already set in, may be arrested, and the constitutional disturbance is at once lessened: the strain on the blood-vessels being taken off, the pulse falls, loses its sharpness, and great relief is afforded. In some forms of inflammatory sloughing, nature relieves the part by free hæmorrhage, as from the dorsal artery in cases of acute gangrene of the penis: and it is not until this has taken place, that the gangrenous action becomes arrested By incision, also, irritating effusions and infiltrations are discharged, and thus one cause of sloughing is removed. Mild local antiphlogistic treatment of an ordinary character is likewise required.

When the gangrene has been arrested, *the fœtor of the sloughs must be diminished* by disinfectant applications, such as the solutions of the chlorides, carbolic acid, or charcoal and yeast poultices. *The separation of the sloughs* should be left as much as possible to nature, which is always fully able to accomplish this, if the patient's strength can be kept up. The vitality of the tissues in the proximity of and above the line of separation is very low, and may readily be destroyed by any fresh action set up in them, there being always a danger of exciting inflammation to such a degree as to exceed that which is necessary for the adhesive variety, and to cause it to run into the gangrenous form. Hence no attempt should be made to pull away sloughs not already separated, nor

should stimulants be applied to the living tissues. It matters little as to what is done to parts already dead, which, when loosened, may be cut away; but we must not meddle with those that are living. Hæmorrhage seldom occurs before the separation of the sloughs, but there is always danger of its happening during that process. If it occur, pressure or the actual cautery will be found the best means to arrest it; and, if these fail, ligature of the artery higher up the limb, or amputation when practicable, might be required.

The parts that are already gangrenous should be enveloped in lint soaked in solutions of carbolic acid, the chlorides of zinc or lime, or creasote, or dusted with charcoal powder and covered with a layer of wadding. No poultices should be applied if the sloughs be large, heat and moisture hastening their decomposition; but if they be small, yeast, carrot, or charcoal poultices may be advantageously applied.

Parts that are quite dead, but that do not readily separate, such as tendons, ligaments, and bones, may be cut through with scissors, pliers, or saws, and thus many weeks or months saved in their separation. It may occasionally be necessary in doing this to encroach on the living tissues; this should be done as carefully and as sparingly as possible, for reasons already stated. The tissues do not bleed much, owing to their infiltration with lymph.

The line of separation should be dressed with water-dressing, or with some mild detergent lotion of ointment, in order to keep the surface clean and to prevent the absorption of gangrenous and septic matters. If sloughs be not readily separated, the balsam of Peru, either pure or diluted with yolk of egg or very dilute nitric acid, and opiate lotions, are the most useful applications. After the separation of the sloughs, the ulcerated surface must be treated on general principles.

The Treatment of Senile Gangrene, presenting some peculiarities, requires a few words to be especially devoted to it.

Constitutional Treatment.—By some Surgeons this disease has been treated on a strictly antiphlogistic plan, on the supposition that the obstruction of the arteries is caused by the inflammation of their coats. This, however true it may be in some of the forms of "spontaneous gangrene" arising from acute obstructive arteritis in young subjects, is certainly an erroneous doctrine in the great majority of cases of dry gangrene occurring as the result of senile changes in the vessels of the lower extremities of aged persons; and, though inflammation may occasionally affect the calcified coats of an artery, or the parts supplied by such a diseased vessel, it is always a low form of the disease, and does not bear depletion. Brodie very justly observes, that in these cases the local precursory inflammation terminates in mortification, because the inflamed part cannot obtain the additional supply of blood that it requires; hence if blood be abstracted from the system, and the action of the heart weakened, the cause of the disease will only be aggravated. But, though depletory measures are not admissible, we must guard against running into the opposite extreme, and overstimulating patients laboring under this disease. Senile gangrene commonly occurs in individuals belonging to the wealthier classes of society, who have lived high, taken insufficient exercise, and consequently induced an irritable, plethoric, but enfeebled state of system. In many cases the patients are of a gouty habit, and occasionally the inflammation that precedes the development of the gangrene appears to be of this nature. In this condition stimulants and the more powerful tonics are not well borne; they heat the system, accelerate the pulse, and interfere with digestion. As Brodie

observes, it is of great importance in this disease to attend to the state of the digestive organs, in order that nutrition may go on, and that blood of a proper quality may be made. In order to accomplish this, a light nourishing diet, partly animal and partly vegetable, should be given, and a moderate quantity of wine, beer, or brandy allowed. The bowels must be relieved from time to time by a rhubarb draught or simple aperient pill. Mercury depresses the system, and hence it should not be used as an aperient in any form in this disease, unless the state of the liver imperatively demand it. If the digestion become impaired, a stomachic, as the infusion of cascarilla or the compound infusion of gentian with a little ammonia, may be administered. The administration of opium in these cases, as originally recommended by Pott, has received the sanction of almost every practical Surgeon. Brodie's opinion on this point is especially valuable; he says, "If I am not greatly mistaken, the result of a particular case will very much depend on this—whether opium does or does not agree with the patient." From two to four grains of opium may be administered in divided doses in the course of twenty-four hours; the quantity being increased as the system becomes accustomed to its effects. If, however, it disturb the stomach and occasion headache, notwithstanding the use of aperients, as will often happen when there is febrile disturbance in persons of a full habit of body, it must be discontinued, as it will increase the irritation of the system. The pain in the foot, which is often very severe during the progress of the disease, usually ceases of itself when the mortification is complete; and before this, it is but little influenced by any sedatives, whether constitutionally or locally applied. With respect to the comparative advantage of the depletory and stimulating plans of treatment in senile gangrene, I think it may fairly be stated that neither method should be applied exclusively; that in those cases in which there is much febrile action, in which the tongue is loaded, the pulse quick, and the skin hot, in which the spread of the gangrene is preceded by a red angry blush, with much pain and heat, moderate diet and mild tonics will be most useful; whilst, on the other hand, when it is simply a shrivelling of the toes and feet, without any preceding increased local action, or febrile constitutional disturbance, a decided tonic or stimulating plan will succeed best.

The **Local Means** to be employed in senile gangrene are simple. It is of great importance to keep up the temperature of the limb, and so equalise its circulation as much as possible; this is best done by the application of cotton-wadding or of carded wool in thick layers around the foot and leg, so as to envelope the limb completely in this material, over which a large worsted stocking may be drawn, or a silk handkerchief stitched. This dressing need not be removed more than once or twice a week, unless there be much discharge from the line of separation, when it must be changed more frequently; the gangrened part itself should be covered with a piece of lint soaked in chlorinated lotion. When the soft parts have been separated, and the bones of the foot exposed, these should be cut across by cutting-pliers or a small saw, and the sores that result dressed in the ordinary way with some astringent lotion or slightly stimulating ointment. The balsam of Peru, either pure or diluted with an equal part of yolk of egg, is a very excellent application in these cases. In the event of recovery, the patient must be careful to avoid exposure to cold, and to keep the legs warmly clad at all seasons of the year.

Amputation in Gangrene.—The question of Amputation in cases of gangrene of the limbs is of great importance to the practical Surgeon, and is one on certain points of which the opinions of the best practitioners still vary. At first sight it appears rational to cut off a limb that is dead, disorganised, and offensive; and with propriety this may be done when the gangrene is, strictly speaking, a local condition, as, for instance, the result of a severe injury; any affection of the constitution in such a case being secondary to the local mischief, and dependent on the irritation set up by it, and on the depression of the powers of life consequent on the efforts made by nature to rid the system of a spoiled member. But when the constitutional disease is the primary affection, and when the gangrene is consecutive to and dependent upon this, it would clearly be useless to cut off the mortified part, as the same morbid action might and probably would be set up in the stump or elsewhere. Hence the broad question of amputation in cases of gangrene turns upon the fact of the mortification being local or constitutional in its origin.

When the gangrene is *local*, we usually amputate at once; especially when the mortification results from severe injuries, or is the result of the wound or ligature of an artery. Here, for the reasons which have been given (pp. 229, 322), amputation should be performed as soon as the gangrene has unequivocally manifested itself, without waiting for the line of demarcation. The result of amputation for traumatic gangrene is, on the whole, very unfavorable; the patient very commonly sinking from a recurrence of the disease in the stump, or from the constitutional disturbance that had previously set in. Those cases are especially unfavorable in which the areolar tissue of the limb is much infiltrated and disorganised; the affection indeed partaking more of the characters of constitutional diseases, with some forms of which it is closely associated.

There are two exceptions to the rule of amputating in traumatic and local gangrene before the occurrence of the line of demarcation; viz., gangrene from frost-bite, and that from severe burns. In these injuries it is better to wait for the formation of the line of separation, and then to fashion the stump through or just above it as the circumstances of the case require.*

In gangrene from *constitutional* causes, it is a golden rule in surgery never to amputate until the line of separation has formed; for, as it is impossible in these cases to say where the mortification will stop, the amputation might be done either too high or not high enough; and, under any circumstances, the morbid action would almost to a certainty be set up in the stump. It is not even sufficient in cases of this kind to wait until the line of demarcation has formed before removing the limb; these cases of spontaneous or constitutional gangrene having often a tendency to remain stationary for some days, and then, creeping on, to overstep the line by which they had at first appeared to be arrested. Besides this, the local disturbance and inflammation set up by the amputation might be too great for the lessened vitality of the system or part, and might of itself occasion a recurrence of the gangrene. Hence in these cases it is always well to wait until the line of separation has ulcerated so deeply that there is no chance of the gangrene overleaping this barrier, at the same time that means are taken, by the administration of tonics, nourishing food, &c., to improve the patient's strength and fitness for the operation. So soon as this has been done in a satisfactory manner, and all the soft parts, except the ligaments,

Fig. 267.—Spontaneous Amputation in Gangrene of Right Foot and Left Leg from Embolism.

have been ulcerated through, the mortified part should be separated by cutting through the remaining osseous, ligamentous, or tendinous structures, and then means should be taken to fashion the stump that has been formed by nature. In some cases this will be sufficiently regular to serve every useful purpose after it has cicatrised. In most instances, however, the stump is more irregular and unsightly (a result of which the accompanying drawing (Fig. 267) is a good illustration); and the bones protrude to such an extent that it is necessary, in order to give the patient an useful limb, to amputate through the face of the stump, or higher up. All this must be left to the discretion of the Surgeon; but no procedures of this kind should be undertaken until the patient's strength has been restored sufficiently to bear the operation.

In *senile gangrene* it has been proposed to amputate the thigh high up. This practice has been successfully adopted by Garlike, James of Exeter, and others, and certainly appears to deserve a trial in all cases in which the health is otherwise good and the constitution tolerably sound. It has not as yet been adopted in a sufficient number of cases to warrant a positive opinion on its merits; but it would appear that, for its success, the amputation should be done high up in the thigh, so that there may be a better chance of meeting with a healthy condition of the vessels and good vitality in the limb; the operation being performed on the principle, that this form of gangrene is dependent on local disease obstructing the vessels of the part, and not always on constitutional causes.

BED-SORES.

When a part of the body is compressed too severely, or for too long a time, even in a healthy person, it loses its vitality, and a local limited slough results; this separates, and an ulcer is left, which cicatrises in the usual way. But in certain deranged states of the health, more especially when the blood is vitiated, and the constitutional powers lowered, as during fever, or when the heart is diseased and weakened, more particularly if the patient be old and debilitated, or if innervation be acutely affected, and he be paralysed, the skin covering those points of the body that are naturally and necessarily pressed upon in the recumbent position, such as the sacrum, the trochanters, the elbows, shoulders, and heels, becomes congested and inflamed, assuming a dull reddish-brown color, and speedily becomes excoriated, often without any pain being felt by the patient. But one great cause of bed-sores is undoubtedly bad nursing. It would not be just to say that a bed-sore is always the result of negligent nursing. But it may truly be said that the chance of the formation of bed-sores, and their severity when formed, will be increased or diminished in the exact ratio of the negligence or care of the nurse. It is not so much the actual severity of the pressure that

occasions a bed-sore, as moderate long-continued pressure applied to a part congested by position in a patient enfeebled by disease or want. If means be not taken to relieve the part from the injurious compression to which it is subjected, and more especially if it be allowed to become irritated by the contact of fæces or urine, the subcutaneous areolar tissue corresponding to the inflamed patch will become extensively softened and doughy, being converted, with the skin covering it, into a tough greyish slough, from under which a thin ichorous pus exudes. This slough may extend by a process of undermining of the integuments covering it; and on its separation extensive mischief will be disclosed, the fascia and muscles being exposed, or the bones even laid bare, and soon becoming roughened and carious. In some cases, even the inferior aperture of the spinal canal may be laid open, and death may result from a low form of arachnitis, in consequence of the irritation spreading to the membranes of the cord. In other cases, the patient dies worn out by discharge and irritation, or becomes pyæmic.

Treatment.—This is in a great measure preventive. When a patient is likely to be confined in bed for many weeks, expecially by exhausting disease, steps should be taken by proper arrangement of the pillows, and by the use of the water-bed and cushions, to prevent pressure from being injuriously exercised upon any one part. At the same time, cleanliness and dryness should be carefully provided for by proper nursing, by the use of a draw-sheet, and furnishing the bedstead with the necessary arrangements of bed-pan, &c. The back should be periodically examined by the Surgeon himself. In certain low states of blood or nerve power, bed-sores of the worst character will very rapidly form. The skin on the exposed parts may be protected by the application of collodion or soap-plaster spread upon wash-leather or amadou, or isinglass on felt; or, what is better, it may be strengthened by being washed with spirits of wine, either pure or with two grains of perchloride of mercury dissolved in each ounce. In some cases much benefit is derived by turning the patient on his side and employing frictions of brandy and glycerine in equal parts. If the skin has become reddened it should be painted with a solution of nitrate of silver, of 5 gr. to 1 oz.

If the skin have become chafed, the removal of pressure is imperative, and the abrasion may be washed over with collodion. If a sore have formed, it may be dressed with the balsam of Peru, either pure or with zinc ointment, spread upon lint. In some cases also the prone couch may occasionally be advantageously substituted for the ordinary bed previously employed. When sloughs have formed, their separation must be facilitated by the use of charcoal or chlorinated poultices, and the ulcers that are left should be dressed with astringent and aromatic applications, such as catechu, tincture of myrrh, &c., and the utmost attention must be paid to cleanliness by the use of antiseptic lotions; but no dressing that the Surgeon can apply will cause these ulcers to clean, and still less to heal, unless pressure be removed and the patient's general health improve, and then they will speedily cicatrise under the most simple treatment.

BOILS.

A **Boil** is a hard circumscribed tumor of a violet or purplish-red color, flattened, though somewhat conical, suppurating slowly, and imperfectly and always containing a small conical central slough of areolar tissue called a *core*. It consists of an inflammation of the subcutaneous areolar tissue and of the under surface of the true skin. The tension and hard-

ness accompanying this affection render it extremely painful and annoying. It is most commonly seated in the thick skin of the back, the neck, or the nates.

CAUSES.—Boils most frequently occur in young people, but are common enough at all ages, and are usually seen either in very plethoric or in very enfeebled constitutions, often following some of the more severe febrile diseases, and attending convalescence from them. In other cases, the system appears to have fallen into a cachectic state, often without any evident cause, and this terminates by a critical eruption of boils. A sudden change in the habits of life, as from sedentary to active pursuits, a course of sea-bathing, &c., will also occasion them. They are commonly met with in the spring of the year, but may occur at all seasons, and are occasionally epidemic. When once they take place they are often extremely tedious, crop after crop continuing to be evolved. In many cases they must be looked upon as salutary, as being the means adopted by nature to rid the patient of morbid matters that irritate the constitution. and which might, if retained, produce disease in it. Hence, after an outbreak of boils, the health often gradually improves.

TREATMENT.—The **Constitutional Condition**, on which the disease is dependent, requires to be carefully attended to. No one remedy is capable of curing boils. The disease is the result, in some cases, of fault or defect in nutrition; and the gradual modification and improvement of those processes that are subservient to it are necessary before the local eruptive affection will cease to appear. In other instances, it appears to be due to want of proper elimination of effete materials. Hence less is often to be expected from medicines in these cases, than from a general regulation of the hygienic condition of the patient. Nature will do more for his recovery than art; and the utmost that the practitioner can do is to administer such remedies as will assist in the improvement of the constitutional condition. If he be debilitated and cachectic, iron, quinine, sarsaparilla, and cod-liver oil; if he be plethoric, and his system loaded, purgatives, salines, and liquor potassæ will be appropriate. In the one case an abundant nourishing diet, in the other case a spare and simple one, with avoidance of stimulants, will be required. In some cases, empirical means are of service. Thus, when the disease is associated, with pompholyx, or preceded by painful vesicles, arsenic may be of benfit. In other instances, yeast or charcoal has been advantageously given.

The **Local Treatment** of boils is simple. When they are forming, the most useful dressing is a warm spirit lotion kept applied with lint and oiled silk; as suppuration comes on, a linseed-meal poultice, either simple or made with port wine, may be advantageously applied. Most commonly the boils may be allowed to break, when they discharge a thick pus together with the central core, thus leaving a small cavity in under the skin, which, however, soon fills up. The Surgeon may in some cases find it necessary to open them by a crucial incision when they are large, and do not appear disposed to break of themselves. When the boil commences as a small irritable pustule, it may occasionally be kept back by touching the point of this with nitrate of silver, or with a saturated solution of perchloride of mercury.

CARBUNCLE.

A **Carbuncle** consists essentially of a circumscribed and limited inflammation of the subcutaneous areolar tissue, rapidly running into suppuration and slough. The rapid formation of pulpy greyish or ash-

colored sloughs of the areolar tissue is characteristic of the disease, whether resulting from the specific nature of the inflammation, or, more probably, from the strangulation of the part by the accumulation of serum and blood, consequent on violent inflammatory action in parts the vitality of which has been materially lowered by constitutional depressing causes.

Signs.—A carbuncle usually begins as a small pointed vesicle situated on a hard base of a dusky red color. There is generally from the first a hot, burning, stinging, heavy, or throbbing pain in the part, out of proportion to the apparent gravity of the disease. The contents of the vesicle speedily become puriform, and are shed. The inflamed base then rapidly enlarges as a flat, painful, hard, but somewhat doughy, circumscribed swelling of the integuments and subjacent areolar tissue. The swelling is of a dusky red hue, slightly elevated, but never loses its flattened circular shape; as it increases in size, the skin covering it assumes a purple or brownish red tint, becomes undermined, and gives way at several points, forming openings through which ash-grey or straw-colored sloughs appear, and from which an unhealthy purulent discharge scantily issues. The size of the swelling varies from one to six inches in diameter; most commonly it is about two inches across. Carbuncles are generally met with on the posterior part of the trunk, more especially about the shoulders and the nape of the neck; being rarely seen anteriorly, or on the extremities. I have, however, had to treat very large carbuncles on the abdomen, and have met with them on the shin, fore-arm, forehead, lips, and cheeks.

The **Constitutional Disturbance** attending this disease is always of the asthenic type; the complexion is often peculiarly sallow or yellow, the pulse feeble, and the tongue loaded; and if the tumor be large, or be seated on the head, death may take place, the patient sinking into a typhoid state.

Causes.—A carbuncle usually arises without any assignable local exciting cause; but in some cases it is evidently directly occasioned by the introduction of some poisonous matter into a puncture in the skin or into a hair-follicle. In all cases it is associated with and dependent upon a disordered, usually a low, state of the constitution. Any condition that lowers the powers of the system will predispose to, and may at last occasion, carbuncle. Habitually bad and insufficient food, the exhaustion induced by chronic wasting diseases, as diabetes, albuminuria, &c., or the debility resulting from acute febrile diseases—more particularly typhus—may all occasion it. Carbuncles are more common in the old than in the young, and men than in women.

Diagnosis.—Carbuncle resembles *boil* in many points, yet differs in its greater size, in the dusky red of the inflamed integument, in its broad flat character, and in the large quantity of contained slough in proportion to the small amount of purulent discharge, as well as in the conditions in which it generally occurs. It also differs from a boil in its tendency to spread. A boil "comes to a head," bursts, and discharges pus and slough; a carbuncle will be discharging and sloughing at one part, whilst it spreads, hard and brawny, at another.

The Prognosis in carbuncle will depend on the size of the swelling, on its situation, and on the state of the patient's constitution, more particularly on that of his kidneys. The most dangerous carbuncles are those that are large, and situated or encroaching on the scalp; in fact, the more this structure is involved the greater the danger. If the constitution be good, even these may be recovered from; but if the kidneys

be unsound, or if there be chronic saccharine diabetes, the progress of the disease cannot readily be checked, and the patient will usually sink.

TREATMENT.—The **Constitutional Treatment** must be conducted on the general principles that guide us in the management of low and sloughing inflammation. After the bowels have been cleared out, the patient should be put on ammonia and bark if much depressed, or else the mineral acids and quinine. The latter in large doses, as much as five grains every four hours, is often of great service. Our great reliance in the more severe forms of the disease is, however, in the free administration of dietetic stimulants and good nourishment. The best medicine in such cases is undoubtedly port wine or porter, given as freely as the patient can take it. The mode of employment of stimulants is of great importance in these cases. As a general rule, that stimulant will agree best to which the patient is accustomed during health. Beer and wine should not be given together, but either will go well with brandy. In addition to stimulants, good and abundant nourishment should be given; meat, if the patient can digest it; if not, soups, such as strong beef-tea, essence of meat, or turtle-soup. The brandy-and-egg mixture is also especially serviceable.

Local Treatment.—In the very early stage, when the disease appears as a small, angry, pointed vesicle situated on a hard brawny base, its further progress may often be completely arrested by opening the vesicle, and rubbing its interior with a pointed stick of potassa cum calce or nitrate of silver. If the carbuncle have attained a somewhat larger size, though still small, the wisest plan is to cover it with a piece of soap-plaster spread on leather, having a hole cut in the centre, through which the pus and sloughy matters may be discharged. Beyond this, nothing will be required. When larger, it should be poulticed. In these cases the question will arise whether it should be incised or not; and, if incised, in what way the operation should be practised. Some Surgeons uniformly adopt incisions; others, with equal constancy, reject them. I think that the exclusive adoption of either method is erroneous, and that the most successful treatment consists in allowing the question of early incision to be determined by the amount of tension existing in and around the carbuncle. Should the parts be soft, relaxed, and comparatively painless, no advantage can result from incision; but, on the other hand, if the tension be considerable, the agony great, and the constitutional disturbance dependent on both, proportionately intense, nothing gives such immediate relief, local and constitutional, as early and free incision. This may be done in two ways; either subcutaneously, by entering a long bistoury at one side of the carbuncle, and making two or three subcutaneous sweeps through the inflamed tissues in planes of different depths; or by a free crucial cut, carried fairly through the diseased parts into the healthy tissues beyond them. By either method the constitutional disturbance accompanying and resulting from the extreme tension is at once removed, the local progress of the disease is checked, and extension of sloughing by strangulation of the tissues is prevented. Should incision of the carbuncle not have been performed early, it may become necessary at a later period, in order to prevent the confinement of the pus and slough. Poultices are now to be applied; these may be simply of linseed meal and water, or they may be made more stimulating by the addition of port wine, yeast, or beer-grounds. As the sloughs loosen, they should be separated; and the granulating surface which is left, and which will usually be found to be sluggish in

its action, should be dressed with some of the more stimulating ointments, such as those of elemi, resin, or balsam of Peru. The ulcer, though large, will when thus treated cicatrise rapidly, and will leave but a small scar.

CHAPTER XXXI.

DISEASES ARISING FROM THE ABSORPTION OF SEPTIC MATTER, OR THE PRODUCTS OF INFECTIVE INFLAMMATION.

Most Surgeons include under this class Pyæmia, Septicæmia, and Hospital Gangrene, and some also the allied disease, Erysipelas. Before discussing this group of diseases more fully, it will be well to consider the meaning of the terms employed. Septic (σήπω, to make rotten or putrid) is used by most writers as almost synonymous with putrid; but the word is also frequently applied to that condition of atmosphere brought about by overcrowding wounded patients, which loads the air with decomposing animal products exhaled from their bodies, and effluvia from their discharging wounds. Thus, we speak of septic fever and septicæmia, meaning thereby, the fever or general blood-poisoning produced by the absorption of putrid (septic) matter from a wound; and we say, a very foul ward is in a septic condition, and that the patients are exposed to septic influences. The term "*infective*" is used to denote an inflammation which, in the words of Burdon Sanderson, "spreads and endures beyond the direct and primary operation of its cause, and which induces similar inflammations in other parts, and disorders the vital functions of the whole body." It has been shown by Burdon Sanderson that this condition of infectiveness may occur in inflammations unconnected in any way with putrefaction. Such inflammations can be produced experimentally, in animals, and acute necrosis of bone is a good example of them occurring in the human subject. Sanderson has also shown that all infective inflammations are characterized by the presence of minute organisms, bacteria or microzymes, in their fluid products. The poison in septic diseases is undoubtedly a product of ordinary putrefaction, but in infective inflammations unconnected with putrefaction, it is supposed to be due to some peculiar change in the fluid of the inflamed part analogous to fermentation. What part the bacteria or microzymes take in the production of the poison, is still a disputed point, as is the similar question with regard to putrefaction. In actual practice, it is rare to see infective inflammation not connected in any way with the presence of putrefying discharges. For example, after an amputation, if a patient be attacked by septicæmia or pyæmia at a time when the discharges are in a state of decomposition, it is impossible to say with certainty whether the secondary disease is due merely to the absorption of putrid matter, or whether some infective inflammation, specific in its nature, has given rise to a poison which has infected the whole system. The well-known fact that many of the most virulent animal poisons, resulting from unhealthy inflammations, lose a considerable degree of potency when allowed to decompose, clearly shows that in these cases, at least, something more than the ordinary products of putrefaction must be present.

Pyæmia, septicæmia, and hospital gangrene appear, in all cases, to be

of septic or infective origin. Septic influences also play an important part as predisposing causes of erysipelas, yet it frequently occurs independently of them. The poison which produces these diseases is always animal in its origin. In surgical practice, its development is usually directly or indirectly the result of overcrowding of patients suffering from suppurating wounds or sores in wards that are either insufficient in size, or that are imperfectly ventilated, or of defective attention to the hygiene of the wound itself. Under the influence of overcrowding of pus-producing wounds, the atmosphere of the apartment becomes loaded with organic matter in a state of decomposition.[1] It has been directly shown, by experiment, that the air, under such circumstances, contains floating in it epithelium scales, and other organic particles; and as Parkes says, "It is a question whether we shall not be obliged to believe that every pus or epithelium cell, or even formless organic substance, floating in the air, may, if it find a proper place or nidus in or on which it can be received, communicate to it its own action, and thus act as a true contagium." It has been established incontestably that if the cubic capacity of a ward be taken, and the rate of ventilation through it determined, a Surgeon may with certainty foretell how many suppurating wounds it will require to generate septic disease in it. If I may venture to use such an expression, I may say that a Surgeon might at any time "grow" septic and infective diseases in a ward by crowding it, beyond its capacity of healthy endurance, with patients suffering from suppurating wounds. These diseases occur therefore in direct proportion to the neglect of hygienic arrangements. They are in most cases the result of certain definite infringements of sanitary rules; they are not accidental; they are preventable, and ought to be prevented, so far as they arise from hospital contamination.

These diseases may probably be produced in several ways. If, as there is every reason to believe, the poison is in some cases nothing more than the ordinary products of decomposition, there is no difficulty in understanding how it may arise in the discharges of a wound. If through unskilled surgical treatment the serous, purulent, or sanious discharges, mixed with air, be pent up in deep cavities, decomposition must result; and the putrescent matter, if absorbed, will give rise to pyæmia and septicæmia. Healthy granulations seem to offer a powerful resistance to such absorption, but in contact with decomposing matter at some degree of pressure they readily slough, and the barrier is then broken down. When, as is undoubtedly frequently the case, the poison giving rise to the disease is something specific, it is carried from one patient to another either by the atmosphere which has become impure from imperfect ventilation, or by dirty dressings, instruments, or fingers. Another method is purely hypothetical. It is supposed by some that a patient may imbibe through the lungs, and possibly the skin, some virus floating in the air, and that his blood may be thus contaminated and that the secretions of the wound may become infective. This view is maintained chiefly with regard to erysipelas, and its supporters adduce in its favor the following facts 1. The constitutional symptoms frequently precede the local by many hours; 2 Erysipelas may arise in cases in which there is no wound; and, 3. The most careful antiseptic precautions, although powerful in the prevention of septicæmia and pyæmia, are far less so in erysipelas. Certain cases are also met with in which all the symptoms of pyæmia arise without the existence of any

[1] See also Chapters I. and II.

external wound or sore. For instance, the pus from beneath the periosteum in acute necrosis has been found to contain bacteria at the time when the abscess was opened and before it could have had any direct communication with the air, and the powerful infective properties of the inflammatory products of this disease are only too well known from the frequency with which it terminates in acute pyæmia. In these cases it must be concluded either that the virus rendering the inflammatory products infective was spontaneously generated within the body, or that, having in some way obtained admission from without, it underwent further development and increase at the inflamed spot. Such cases as the above are, however, very rare, and should in no way lead us to doubt that the vast majority of all septic and infective processes in open wounds arise from causes attacking the wound directly, and are the result of faulty sanitary arrangements or of imperfect wound hygiene.

Of the nature of the poisons causing these various diseases we know little. The observations of Burdon Sanderson tend to show that they are "incapable of diffusion (in liquids), and, therefore, in the strict sense insoluble," and that they are invariably associated with the presence of microscopic organisms; but evidence is still wanting to show certainly whether these organisms produce the virus, serve merely as carriers of it, or only coexist with it. Each view has its supporters. Experiments by Baxter, undertaken on behalf of the Privy Council, show that the most virulently infective products have their activity destroyed by disinfectants, such as carbolic acid, chlorine, sulphur dioxide, and potassic permanganate. There is reason to believe that the poison or poisons giving rise to pyæmia and septicæmia are identical, the variety of the disease depending on circumstances to be discussed hereafter. The virus of erysipelas is probably specific and entirely distinct from that causing the two former affections. The same may be said of hospital gangrene.

Thus, although the different septic diseases are developed by much the same methods, there is every reason to believe that they do not arise from the generation of the same septic influence; but that each septic disease is the result of the impregnation of the wound, or the contamination of the system by a different poison, such poison being capable only of producing its own special or specific disease. That this is so appears probably from the fact that septic diseases are not interchangeable; that one does not run into the other; that one type will prevail at one period, another one at another time. Each is a distinct and specific affection, and though arising generally under the influence of the same favoring circumstances, each is the outcome of a special septic poison.

We will consider them more in detail.

SLOUGHING PHAGEDÆNA.

This affection, which is also known by the names of **Hospital, Contagious, or Pulpy Gangrene**, is characterised by a rapidly destructive and spreading ulceration, covering itself as it extends by an adherent slough, and attacking open sores and wounds. It is rarely met with in its fullest extent, except in military practice; the accumulation of a large number of wounded persons with suppurating sores under one roof, and the want of the proper cleanliness and attention during an active campaign, disposing to it. Overcrowding of a hospital is the most fertile cause of this disease, as well as of other septic diseases. It used formerly to desolate the civil hospitals; but, thanks to the sanitary measures now generally adopted in these institutions, it has almost dis-

appeared from them, though still an outbreak of it occasionally takes place, more especially during the winter or early spring months, when, in consequence of cold winds, the windows are kept shut and ventilation is thus interfered with. But the occurrence of this foul disease is of itself condemnatory of the sanitary arrangements of the hospital in which it is developed, and in the present state of our knowledge is inexcusable.

Local Signs.—When sloughing phagedæna invades a wound or open sore that has hitherto been perfectly healthy, the surface becomes covered with grey soft points of slough, which rapidly spread, until the whole of the surface of the wound is affected. At the same time the sore increases rapidly in superficial extent, and commonly in depth; the surrounding integument becomes œdematous, swollen, and of a livid red color; the edges of the ulcer are everted, sharp-cut, and assume a circular outline; and its surface is covered with a thick pulpy greyish-green tenacious mass, which is so firmly adherent that it cannot be wiped off, being merely moved or swayed to and fro when an attempt is made to remove it. There is usually some dirty yellowish-green or brownish discharge, and occasionally some bleeding; the pain is of a severe burning, stinging, and lancinating character; and the fœtor from the surface is great. The ravages of this disease, when fully developed, are very extensive. The soft parts, such as the muscles, areolar tissue, and vessels, are transformed into a grey pulpy mass, and the bones are denuded and necrosed. The larger blood-vessels resist the progress of the disease longer than any other parts, but may at last be exposed, pulsating at the bottom of the deep and foul chasm. There is, however, little risk of hæmorrhage in the early stages: but, when the sloughs are separating, an artery may give way, and bleeding to a dangerous or fatal extent ensue. Hennen states that there is most danger of this about the eleventh day. When the sloughs are thrown off, in the form of reddish-brown or greyish-green, viscid, and pulpy masses, a very sensitive granulating surface is left, having a great tendency to bleed, and to be again invaded by the sloughing action.

Blackadder has described an ulcerated form of this affection, in which a vesicle containing a bloody ichor forms, with a hot stinging pain; this breaks, leaving a circular ulcer about the size of a split pea. The ulcer once formed, rapidly extends by sharp-cut edges into the surrounding integument.

On the two occasions in which I have had, in former years, the opportunity of witnessing outbreaks of this disease in University College Hospital, the surface of the wounds affected became rapidly covered with a yellowish-grey pultaceous slough. In some cases there was hæmorrhage; but most commonly a small quantity of fœtid discharge only was poured out, the edges of the sore became sharp-cut and defined, and the ulceration extended further in the skin by an eighth or a quarter of an inch than in the subjacent areolar tissue. In most instances the disease was confined to the skin and areolar tissue, exposing but not usually invading the muscles and bones, though in some cases these were affected. The ulcers were somewhat circular, and were surrounded by dusky inflamed areolæ of some width. When once the morbid action was stopped, they cleaned rapidly, throwing out large vascular granulations.

Constitutional Symptoms.—In the early stage these may exhibit evidence of active febrile disturbance, with high temperature and quick pulse. But they soon subside into symptoms of asthenia and prostration. In the majority of cases they follow the local invasion of the sore;

Blackadder, Rollo, Delpech, and Wellbank have all found this to be the case, and in the instances at University College Hospital it certainly was so. Hennen and Thomson, on the other hand, state that the constitutional symptoms precede the local. In this I believe them to be certainly in error. They have confounded that state of ill health which occurs in the wounded who are confined in the foul and reeking atmosphere of an over-crowded military hospital, and which predisposes to the invasion of hospital gangrene, or of any other septic disease, with the symptoms produced by the phagedæna itself.

Causes.—All wounds and sores are liable to be attacked in this way, but the disease most frequently affects those that are of recent origin; the more chronic affections, and those that are specific, very usually escape. It is in military hospitals, during active warfare, that sloughing phagedæna is now chiefly met with. The experience of many wars has led incontestably to the conclusion that hospital gangrene will certainly be developed amongst the wounded if they are aggregated in large numbers under one roof, however large and well ventilated may be the building; whilst, amongst the wounded who are treated in the open, or in "hut-hospitals"—mere temporary sheds—it is all but unknown. No better illustration can be given of the undoubted fact that the disease is primarily generated by a septic, *i. e.*, poisonously putrid state of the atmosphere occasioned by the accumulations of the exhalations from the wounds, bodies, excreta, and clothes of many injured people collected into one building.

Overcrowding of patients, more particularly those with suppurating wounds, in the same ward or room, is the great occasioning cause of hospital gangrene and sloughing phagedæna. I believe that in this way the disease may at any time be produced. The last outbreak that occurred at University College Hospital was clearly referable to that cause, and that cause only, more than a quarter of a century ago. In one of my wards, which is intended to contain 15 or 16 patients only, owing to accidental and unavoidable circumstances, 21 patients were admitted, and slept for one night, many of them having suppurating wounds. The result was an outbreak of hospital gangrene, which spread through the Institution, and was most serious and persistent. Next to overcrowding, I believe that the most fertile causes of this disease are want of cleanliness and ventilation, and the retention of soiled and dirty dressings. The accumulation, indeed, of animal exhalations from the sick and wounded, is a cause of various forms of low fever and of allied diseases; and hospital gangrene, when it occurs in these circumstances, may be taken as evidence of the infringement of the sanitary laws in accordance with which the arrangements of an hospital should be regulated. But though it commonly has its origin in this way, especially in the crowding of military hospitals after a hard-fought action, it is met with out of hospitals. Well-marked cases of this affection, some of a very severe character, have at times occurred amongst the out-patients of University College Hospital. In these cases, as in many others, it is probable that the disease was occasioned by the neglect of hygienic conditions, in the close and ill-ventilated houses of the poor, aided possibly by some atmospheric or epidemic influence; influenza, erysipelas, and phlebitis being also very prevalent. This had been observed at the time of the first occurrence of the disease at our Hospital, in 1841; and it is impossible not to recognise a similarity of cause in these different affections. It is a highly contagious disease, and when once it has broken out it will readily spread from patient to patient by contact with nurses'

or Surgeons' fingers, instruments, dressings, and above all if the pernicious custom of using sponges in wards be adopted. It is impossible to be too careful in these respects. It may also be carried by organic particles in the air, and thus be said to be infectious.

TREATMENT.—The **preventive treatment** of hospital gangrene may be deduced from a consideration of the causes that give rise to it. It ought never to occur in a civil hospital. Its presence there is the severest condemnation that can be given of the sanitary condition of the Institution, and is an evidence that those arrangements which ought to exist in every well-conducted hospital are neglected. By avoiding overcrowding it need never occur. In military practice its prevention may almost to a certainty be secured by treating the wounded under canvas, in "hut hospitals," or in the open. Should it break out, the building in which it has developed itself should at once be abandoned or destroyed.

The spread of this fell disease may be prevented by at once isolating the affected patient, treating him in the open, putting him as it were in quarantine, allowing no contact between his attendants and other patients. Should it have broken out in a civil hospital, the first point to attend to is to *prevent the extension of the disease* to patients who are not as yet affected. This may be done by separating those who have been seized with it from the healthy, by preventing over-crowding of the hospital, ventilating the wards, washing the floors with a solution of the chlorides, whitening the walls, and fumigating the apartment with chlorine gas.

Local Treatment.—The *extension of the slough* must be stopped by the free application of fuming nitric acid, or of the actual cautery, to the edges and surface of the ulcer. I have used both these agents, but prefer the nitric acid, if strong and freely applied, the sides and edges being well sponged with it. The actual cautery is, however, very useful in those cases in which the surface to be destroyed is very extensive, or if there be a tendency to hæmorrhage. Should it not reach the deeper portions of the sore, nitric acid may be freely sponged into them. It is important to bear in mind that these escharotic applications should be carried deeply, so as to affect the living structures lying beneath the tenacious grey pulpy slough, and that their action be not fruitlessly expended upon charring this, which is already disorganised. Hence, before the application of the caustic, the soft pulpy slough should be scraped off with a spatula. After the cauterisation a strip of lint, soaked in a strong solution of the watery extract of opium, should be laid around the margin of the ulcer, so as to cover the surrounding areola; and the separation of the sloughs must be encouraged by the continued application of charcoal, yeast, or chlorinated poultices. In many cases *iodoform* will be found preferable to caustics or the cautery. It gives little or no pain when dusted over the sore, arrests the progress of the sloughing action, and clears away the sloughs themselves in a most remarkable manner. When the sloughs have separated, and the surface of the sore has cleaned, it may be dressed with a lotion composed of one grain of the sulphate of copper and five of the watery extract of opium to an ounce of water. The granulations, which are very luxuriant and vascular, will skin over with great rapidity; and the cicatrix, like that of an ordinary burn, will contract very firmly.

Should *arterial hæmorrhage* occur, it may be arrested by the application of a ligature to the bleeding point; but if this do not hold, as will probably be the case from the softened state of the tissues, the perchlo-

ride of iron or the actual cautery must be applied; or the limb must be removed if all other means fail.

In some cases, though the sloughing action is checked at one part of the surface, it has a tendency to spread at another. When this is the case, it may be necessary to apply the caustic or cautery repeatedly. In other instances, the sloughing action cannot be stopped, but opens large arteries, and destroys the greater part of the soft tissues of a limb; and then it may be a question whether amputation should be performed during the spread of the disease, or the patient left to die of hæmorrhage or exhaustion. Such a contingency is not of common occurrence; yet it may happen and the operation be successful, as appears from the following case, though there would necessarily be great danger of a recurrence of the disease in the stump. The wife of a butcher applied at the Hospital, with a slight wound of the fore-arm, inflicted by a foul hook. It was dressed in the ordinary way, but in the course of a few days she returned with extensive sloughing phagedæna of the part. She was immediately admitted, and the disease was arrested by the energetic employment of the local treatment above described; not, however, until after considerable destruction of the tissues on the inside of the fore-arm had taken place. She left the Hospital before the wound was completely cicatrised, and returned in a few days with a fresh attack of the disease, more extensive and severe than the first, which could not be permanently stopped, either by the actual cautery or by nitric acid. The radial artery was opened and required ligature, and the whole of the soft parts, from the wrist to the elbow, were totally disorganised, and the bones exposed. There was now very severe constitutional irritation, and the case was evidently fast hastening to a fatal termination. In these circumstances I amputated the arm midway between the shoulder and elbow; and, notwithstanding that the local disease was progressing at the time of the operation, and that great constitutional disturbance existed, the patient having a pulse of 160 to 170, at which it continued for more than a fortnight, she made a good recovery; to which the free administration of quinine and stimulants greatly contributed.

The **Constitutional Treatment** consists in as nourishing a diet as the patient will take, with a liberal supply of stimulants; and these may be increased by the addition of the brandy-and-egg mixture, or of ammonia, in proportion as depression comes on; from five to seven grains of the sulphate of quinine should be given every four or six hours, with a full dose of opium at bed-time, or more frequently if there be much pain and irritation.

GANGRENOUS STOMATITIS, OR CANCRUM ORIS.

A peculiar phagedænic ulceration, closely resembling hospital gangrene, is occasionally met with in the mouths of ill-fed children living in low and damp situations, most commonly occurring between the second and sixth or eighth years, but more especially about the period of the second dentition.

In the mildest form this affection presents itself as small, deep, and foul greyish ulcers, on the inside of the lips or cheeks, attended with a red spongy condition of the gums and much fœtor of the breath. Good food and air with nourishing diet, the administration of bark, with the chlorate of potash, and the use of chlorinated lotions, with the honey of borax, will soon bring about a cure.

Signs of Cancrum Oris.—The more severe form of the affection, the true **Cancrum Oris**, commonly occurs during convalescence from some

of the eruptive diseases of childhood, or after the incautious administration of mercury during a weak state of the system. One of the cheeks becomes swollen, brawny, tense, and shining, being excessively hard, and presenting a red patch in its centre. In consequence of this swelling, it is often difficult to open the mouth; but if the Surgeon can gain a view of its inside, he will see a deep and excavated foul ulcer opposite to the centre of the external swelling, covered with a brown pulpy slough. The gums are turgid, dark, and ulcerated; the saliva is mixed with putrescent matters; and, as the ulceration in the mouth extends, the swelling sloughs, and a large, dark, circular gangrenous cavity forms in the cheek, opening through into the mouth. During all this time the child suffers little, but, as the disease advances, it commonly becomes drowsy, and at last dies comatose. When fully developed, this affection is most fatal. Rilliet and Barthez state that not more than one in twenty cases recovers.

Treatment.—The treatment is that of hospital gangrene. The sloughing mass should be deeply cauterised with nitric acid, but not with the actual cautery, lest the cheek be destroyed; the mouth should be syringed out with the dilute solution of the chlorides; and the system supported with beef-tea, wine, and ammonia, in doses proportioned to the age of the child. After the cure of the disease, the cheek may be deeply cicatrised, contracted, and rigid, much in the same way as after a burn, requiring possibly some plastic operation in order to enable the child to open its mouth properly.

CHAPTER XXXII.

ERYSIPELAS.

Erysipelas so frequently and seriously complicates most other surgical diseases and injuries, that its study is of the utmost importance to the practical Surgeon. It usually manifests itself as a peculiar and distinct form of inflammation of the skin, having certain special characters which distinguish it from the ordinary inflammation already described. Erysipelas, or, as it may be termed, the *Erysipelatous Inflammation*, including all those varieties of this condition that are usually spoken of as "*diffuse*," has a remarkable tendency to spread with great rapidity by continuity of surface, to change its seat, and not to be limited by any adhesive action. It may extend itself over any continuous surface; the skin, the areolar tissue, the mucous and serous membranes, and the lining membranes of arteries, veins, and lymphatics, are all liable to be affected. Hence, to describe it merely as a *cutaneous* disease, a dermatitis, as has often been done, is not only highly incorrect, but unphilosophical, and often evinces a very limited acquaintance with its true nature. It affects the skin more frequently than other membranous surfaces, simply because the skin is more frequently than any other texture in the body the seat of wounds—the most common exciting cause of this disease. Indeed, not only must we look upon erysipelas as a disease that may affect any surface, external or internal, but we must consider the constitutional disturbance that takes place in erysipelas as the essential morbid condition. This, it is true, is usually complicated with dif-

fuse inflammation of the integument and areolar tissue, and then constitutes one of the ordinary forms of erysipelas. But a constitutional fever may occur of precisely the same type as that which we observe to precede and to accompany the local inflammation, without any such complication. This I had special occasion to observe in a very fatal outbreak of erysipelas that took place in one of my wards some years ago. On that occasion, all the cases in which the cutaneous form of erysipelas appeared were marked by severe constitutional disturbance, attended by much gastro-intestinal irritation. But precisely the same type of general febrile symptoms, and the same irritation of the stomach and bowels, occurred in patients in the same ward in whom no local or surface manifestation of the disease took place. The true pathology of the diffuse, low, or erysipelatous inflammations has yet to be made out. They are all closely connected with one another, and are evidently blood or constitutional diseases, under whatever name they go. The similarity of causes, of effects, and of constitutional disturbance, makes it probable that they are all essentially dependent on one common condition of the blood; and that the particular local manifestation that occurs is secondary to this, and perhaps in some degree accidental, and dependent on varying local conditions.

A chief characteristic of this erysipelatous fever is its incompatibility with the localisation of any inflammation that may exist at or occur after its invasion; and hence, when it attacks the system, it causes already existing inflammations to become diffuse or spreading, and to extend themselves over any surface on which they happen to be situated. It is, in fact, the very antithesis of the adhesive inflammation; and not only is it so, but when erysipelas attacks a wound in which the healing process has made any progress, it has a tendency to disorganise the lymph that has been already deposited, to open up the wound, and to lead to the establishment of suppurative action in it. It is especially apt to cause those inflammations to spread, which have not already been localised by the deposit of adhesive matter. Hence, recent wounds are more liable to be affected by it than old, and more especially granulating ones, in which the inflammation has already taken on a plastic character, which requires to be overcome before the diffuse form can set in.

The invasion of erysipelas is characterised by general malaise and depression, chilliness, and occasionally actual signs, gastro-intestinal disturbance, accompanied by nausea, and sometimes by violent vomiting and purging. Cases have been recorded in which the first symptoms have been convulsions of an epileptiform character. During the chilliness the temperature rises to 103° or 104° F.; but the rise does not show the extraordinary fluctuations common in pyæmia. The constitutional disturbance, although usually at first sthenic, very speedily runs into an asthenic or irritative type, presenting in severe cases the usual typhoid symptoms—a quick feeble pulse, brown tongue, pungent hot skin, and muttering delirium. The disease is truly an affection of debility; it is in consequence of the want of a sufficient degree of power in the part, or in the system, for the deposit of plastic matter, and the limitation of the inflammation by this, that the local affection spreads itself unchecked along the surface it invades. The tendency that frequently exists in erysipelas to the occurrence of sloughing and suppuration of the affected tissues, is a further indication of the asthenic and low character of the disease. This view of the nature of the constitutional disturbance in erysipelas is of great importance in reference to the treatment of the disease, as it demonstrates the necessity of not lowering the patient's

powers too much during the early period of the affection, when it often temporarily assumes a truly sthenic character.

Erysipelas is especially apt to become complicated with low visceral inflammation; the membranes of the brain, the bronchi, and the lungs, or the gastro-intestinal mucous surface, are commonly implicated in this way; and it is often through these complications that death results.

CAUSES.—Erysipelas may occur without any external wound, injury, or lesion of any kind, the disease being occasioned by some external agency, such as cold acting injuriously on a system previously disposed to it by habitual derangement of health. Or it may be directly excited by the infliction of a wound in an individual who is either strongly predisposed to this affection by previous constitutional derangement, or who is after the receipt of this injury exposed to circumstances that favor the development of the disease. Erysipelas may be predisposed to by two distinct sets of causes: 1. Those that are *intrinsic* to the patient—that are constitutional, dependent upon the state of his general health; and 2. Those that are *extrinsic*—those conditions of life to which he has habitually been exposed, or by which he is surrounded after the injury or operation to which he has been subjected.

1. **Intrinsic Causes.**—The great predisposing cause of erysipelas is to be sought for and will be found in a *want of attention to hygienic conditions*. It is one of the penalties inflicted by nature on those who neglect those prime requisites of health—temperance and cleanliness, or who are incapable of obtaining good food and pure air. Were the laws of hygiene attended to as they should be, erysipelas and the allied diffuse inflammations would rarely be met with in surgical practice. Some persons appear to be *naturally predisposed* to erysipelas to so great a degree, that the application of cold, or slight stomach-derangement, or a trivial superficial injury, may excite it. This predisposition is most generally acquired by habitual derangement of health, and is especially induced by any of the depressing causes of disease, such as over-fatigue, anxiety of mind, night-watching, and habitual disregard of hygienic rules as to diet, exercise, air, &c. The habit of body, however, in which erysipelas is most frequently met with as a consequence of very trivial exciting causes, is that which is induced by the habitual use of stimulants to excess. It is more especially in that state of the system characterised by an admixture, as it were, of irritability and of debility, in which inflammation is not followed by the deposition of plastic lymph, but has a rapid tendency to the formation of pus and slough, and to extension of disease in a diffuse form, that erysipelas is very readily induced. This state is met with among the laboring poor, as the result of the privation of the necessaries of life, conjoined with the habitual over-use of stimulants and exposure to the various depressing conditions of bad food, impure air, &c. Amongst the wealthier classes it occurs as a consequence of high living, want of exercise, and general indulgence in luxurious and enervating habits.

Some *diseased states of the blood* appear to predispose, in the highest degree, to the supervention of erysipelas. This is especially the case in diabetes, and in disease of the kidneys attended by albuminuria. As a consequence of renal disease, erysipelas often occurs idiopathically, or from the most trivial causes; such as a scratch, the sting of an insect, or any of the minor operations in surgery, more especially about the lower part of the body. Not only is it readily induced in this way, but it will extend in an uncontrollable manner in these states of the system, and will often assume a gangrenous form, there being apparently an

utter want of limiting or reparative power in any inflammation, however set up. Persons of a gross and plethoric habit, with a tendency to gout, are predisposed to the occurrence of erysipelas. The blood-degeneration that attends malignant disease peculiarly disposed to erysipelas, which accordingly more freqently takes place after operations on persons having such diseases than after the removal of simple tumors.

Persons whose *nervous systems* are habitually depressed, the semi-idiotic and idiotic for instance, are very prone to low diffuse and sloughing inflammations of an erysipelatous form.

2. **Extrinsic Causes.**—Amongst the circumstances that surround the patient and that tend to the production of this disease, season of the year and atmospheric changes exercise a marked influence. Erysipelas is usually supposed to be more frequent in the spring and autumn, and the experience at University College Hospital during the past four years, for which time the records of such cases have been very accurately kept, tends to confirm this idea. Thus we find that during the years 1871–2–3–4, 151 cases of erysipelas were treated in the Hospital, including those admitted for the disease and those affected by it while undergoing treatment for other affections. Of these, 34 occurred during the cold months of December, January, and February; 43 during March, April, and May; 22 during the hot months of June, July, and August; and 52 during September, October, and November. It is an interesting fact, that during these four years only one case arose during the month of July. It has frequently been asserted that erysipelas often breaks out on the setting in of cold easterly winds or on sudden atmospheric changes. Observations were made during one year (1872) at University College Hospital with the view of testing the truth of this assertion; but, as they were not continued after that year, the time over which they extend is not sufficient to exclude chance from the results. As far as they went they tended to show that mild damp weather, with westerly winds, is a more powerful predisposing cause of erysipelas and other hospital diseases than cold dry weather with easterly winds, that is to say, exactly the reverse of the popularly received opinion. The subject is one of great interest, and is well worthy of further investigation. Erysipelas often becomes epidemic as the result of peculiar, but at present inexplicable, conditions of the atmosphere. Thus at University College Hospital the number of cases occurring during the four years before mentioned was as follows: in 1871, 29; in 1872, 29; in 1873, 26; in 1874, 67. And not only was it at University College Hospital that this excess of erysipelas was noticed, but every similar institution in London suffered in the same way. It will usually be found that, when erysipelas is very abundant among the in-patients of a hospital, similar cases present themselves for treatment in the out-patient department, and at the same time it is usually noticed that phlebitis of varicose veins, epidemic catarrh, acute tonsillitis, and other allied affections prevail. Epidemic erysipelas may vary in its type. Thus the epidemic of 1874 was chiefly of the cutaneous variety, and was accompanied by comparatively slight tendency to gangrene or sloughing; while that in 1872, in Edinburgh, was of a violent phlegmonous type, usually attacking the subcutaneous tissue and leading to extensive diffuse sloughing and suppuration.

But not only is erysipelas epidemic; it is also *contagious*. The contagion of erysipelas, after having been repeatedly denied, can no longer be contested. Travers, Copland, Bright, Nunneley, and others, have adduced cases in proof of its contagious character; and instances have repeatedly fallen under my own observation, in which erysipelas, often

unfortunately fatal, has been communicated to the servants, nurses, or relatives of patients affected by it. A remarkable proof of the contagious nature of erysipelas occurred in the winter of 1851, in one of my wards at University College Hospital. The Hospital had been free from any cases of the kind for a considerable time, when, on the 15th of January, at about noon, a man was admitted under my care with gangrenous erysipelas of the legs, and placed in Brundrett Ward. On my visit two hours after his admission. I ordered him to be removed to a separate room. and directed the chlorides to be freely used in the ward from which he had been taken. Notwithstanding these precautions, however, two days after this, a patient, from whom a necrosed portion of ilium had been removed a few weeks previously, and who was lying in the adjoining bed to that in which the patient with the erysipelas had been temporarily placed, was seized with erysipelas, of which he speedily died. The disease then spread to almost every case in the ward, and proved fatal to several patients who had recently been operated upon. In some instances patients were affected with the constitutional symptoms without any appearance of local inflammatory action, but characterised by the same gastro-intestinal irritation that marked the other cases.

Erysipelas may not only spread in this way from patient to patient, but any *diffuse inflammation*, as phlebitis, inflammation of the absorbents, low or puerperal peritonitis, may give rise to external erysipelas, and in its turn be occasioned by it—a strong argument in favor of the allied or even identical nature of all these affections. Then, again, the *contact of dead or putrescent animal matters* with recent wounds may occasion it. In this way the disease is not unfrequently originated in hospitals by dressers going direct from the dead-house, and especially from the examination of the bodies of those who have died of diffuse inflammation, to the bedside of patients, without taking sufficient care to wash their hands or change their clothes. For this reason also it is of great consequence that the same instruments be not used for practising operations on the dead, and performing them on the living body. *Overcrowding* of hospitals, and *want of proper ventilation* in wards or rooms, are fertile sources of erysipelas, and of the allied low inflammations; in fact, an outbreak of erysipelas might at any time be induced in this way amongst patients in all other respects healthy and well cared for.

The principal **Exciting Cause** of erysipelas is certainly *the presence of a wound*. It is chiefly recent wounds, however, that are affected; when once the adhesive or suppurative inflammation is set up, the wound is not so liable to take it on unless it be in bad constitutions, the formation of limiting fibrine appearing to lessen the liability to the occurrence of the disease. When erysipelas is epidemic, it is well for the Surgeon not to perform any operation that can conveniently be postponed; and in no case should a patient on whom an operation has recently been performed be put in a neighboring bed to a case of erysipelas, or even in the same ward. The size of the wound has little influence on the occurrence of erysipelas, which takes place as readily from a small as a large one. But although the mere size of a wound does not influence the liability to the occurrence of erysipelas in it, which will as readily follow a puncture as an amputation-wound, yet its character does. Thus, lacerated wounds are much more liable to be followed by erysipelas than clean-cut incisions. And the depth of the wound influences in an important manner the severity of the erysipelas, which is more intense in

those injuries that penetrate the fasciæ, even though this be cut to a very limited extent, when the disease may spread widely and fatally through the deeper subaponeurotic and intermuscular planes of areolar tissue. Injuries about the head and hands are those that are most liable to be followed by this disease.

But, though we must constantly bear in mind the constitutional nature of erysipelas, it will be more convenient and practical to describe it as it affects different tissues and organs. With this view we may divide it primarily into External and Internal Erysipelas.

EXTERNAL ERYSIPELAS.

External Erysipelas is that variety of disease which affects the skin and subcutaneous areolar tissue. This form has been described with an absurd degree of minuteness, so far as the transitory and accidental characters of its duration, shape, and appearance are concerned, by many of the writers on Diseases of the Skin; who, in their anxiety to record minute and often accidental shades of difference in appearance, have entirely lost sight of the true nature of the disease. The division adopted by Lawrence into the **Simple**, the **Œdematous**, and the **Phlegmonous** forms, is a practical arrangement that is commonly adopted by Surgeons. I prefer, however, and shall adopt, the division made by Nunneley in his very excellent work on Erysipelas, as founded on the true pathology of the affection. He arranges external erysipelas under three varieties: 1. **Cutaneous**; 2. **Cellulo-cutaneous**; and 3. **Cellular.**

1. Cutaneous Erysipelas is the slightest form of the disease, implicating merely the skin; it comprises many of the species of *erythema* of different writers, and corresponds to the **simple erysipelas** of Lawrence.

Local Signs.—A patient is seized with rigors, alternate chills and flushes, followed by headache, nausea, a quick pulse, a coated tongue, and hot skin; in from twenty-four to forty-eight hours the rash appears, though sometimes it comes out simultaneously with the constitutional disturbance. If there be a wound, its secretions dry up, and the margins become slightly swollen, and affected by the red blush. If the disease occur idiopathically without a wound, it most commonly appears upon the face, next upon the legs, and lastly upon the trunk. The rash is of a uniform but vivid rosy red hue, sometimes becoming dusky, and always disappearing on pressure; when advancing it is characterised by a sharply defined border slightly raised above the healthy skin, but when subsiding it fades into the color of the healthy skin. It is accompanied by some slight œdematous swelling, frequently only recognisable by the permanent impression left by the finger nail pressed on the skin, but which is often considerable where the areolar tissue is loose, as in the eyelids and scrotum, and there is usually a stiff burning sensation in the part, and not unfrequently greatly increased sensibility. Vesicles or bullæ often form, containing a clear serum, which speedily becomes turbid, and dries into fine branny desquamation. The redness may spread rapidly along the limb or trunk, or, if the face be affected, may travel quickly from one side to the other, causing such swelling of the eyelids as to close them, and giving rise to swelling and much tensive pain in the ears. The disease is almost invariably accompanied by some enlargement and tenderness of the lymphatic glands. In some cases this may even precede the rash. Sometimes the disease disappears in

one part of the body and reappears in another. This, which is the *erratic* erysipelas, is often a dangerous form of the affection, occurring in advanced stages of pyæmia, and indicating the approach of death. In these varieties of idiopathic erysipelas, Arnott states that the fauces are always involved. This affection does not usually induce any serious mischief in the part, but in some cases abscesses form, more especially in the loose areolar tissue of the neck and of the eyelids. When the inflammation is passing off the pain abates, the color fades, the swelling subsides, and the cuticle, that has been detached by the serous transudation, flakes off in thin layers. In other cases, œdema of the part continues, with some irritability and redness of the skin and peeling of the cuticle; and in some rare cases the simple erysipelas seems to take on a gangrenous or sloughing character, especially about the umbilicus and genitals of young children.

The *Constitutional Symptoms* of the cutaneous or simple erysipelas present every variety between the sthenic and asthenic forms of inflammatory fever. When the disease occurs in London, it certainly most frequently assumes a low type. There is also in most cases a good deal of derangement of the digestive organs; the tongue being much coated, there is tenderness about the epigastrium, the evacuations are dark and offensive, and not unfrequently there is diarrhœa. When the scalp is affected, severe headache, with symptoms of cerebral inflammation, are often met with; indeed there is always a danger of the supervention of cerebral complications in cases of erysipelas of the face or scalp, and it may be said that the cutaneous form of erysipelas disease seldom proves fatal unless the scalp be affected, and the brain consequently implicated. Even after a comparatively slight attack the patient is usually much reduced in strength, being frequently left in an anæmic and emaciated condition.

2. CELLULO-CUTANEOUS OR PHLEGMONOUS ERYSIPELAS differs from the last variety in the degree of inflammation, and in the depth to which the tissues are involved. The intensity of this form of inflammation is so great that it invariably terminates, if left to itself, in diffused suppuration and sloughing. In depth it always extends to the subcutaneous areolar tissue, and, though generally bounded by the underlying fasciæ, it not unfrequently implicates them if they have been opened up, and extends to the intermuscular areolar planes, the sheaths of the tendons, and other deep structures.

Local Signs.—The cellulo-cutaneous or phlegmonous erysipelas is ushered in by the ordinary symptoms of inflammatory fever, accompanied or followed by the signs of severe inflammation in the part affected. The redness is uniform, of a deep scarlet hue, and pretty distinctly bounded; the pain is from the first pungent and burning, though it may soon assume a throbbing character; the swelling, at first soft, diffused, and admitting of distinct pitting, soon increases, and becomes tense and brawny, the skin being evidently stretched to its full extent, and the part appearing perhaps to be twice its natural size. Large vesications or blebs containing sero-purulent fluid, sometimes of a sanious tinge, appear in many cases. This condition usually continues up to the sixth or eighth day after the invasion of the disease, during the whole of which time the constitutional symptoms have presented the ordinary type of sthentic inflammatory fever; about this time, however, a change commonly takes place, either for better or for worse. If, under the influence of proper treatment, and in a tolerably healthy constitution, the inflammation subside, resolution takes place, with a gradual abatement

of all the symptoms. If, however, as usually happens, the disease runs on to more or less sloughing or suppuration of the part, no increase of the swelling, pain, or redness takes place, but, on the contrary, some diminution of these signs may occur, and thus give rise to a deceptive appearance of amendment. The skin becomes darkly congested, and the part, instead of being tense and brawny, has a somewhat loose, soft, and boggy feel, communicating a semi-fluctuating, doughy sensation to the fingers. This change from a tense brawny state to a semi-pulpy condition indicates the formation of pus and slough beneath the integument, and occurs without any material alteration in the size, color, or general appearance of the part, but can only be detected by careful palpation; hence the Surgeon must daily examine with his own fingers the state of the part, and neither trust to the reports of others, nor to the general appearance of the diseased structures, for a knowledge of the probable condition of the subjacent tissues. If an incision be now made into the affected part, the areolar membrane will be found loaded with an opalescent fluid distending its interstitial loculi, but not flowing from the wound; the retention of this fluid gives a gelatinous appearance to the sides of the incision, which rapidly degenerate into slough and pus. If the alteration in structure have advanced to a stage beyond this, the areolar tissue will be found to have been converted into dense masses of slough, bathed in thin and unhealthy ichorous pus; these sloughs have not inaptly been compared in appearance to masses of decomposed tow, of wet chamois leather, or to the membranes of an embryo a few months old. Whilst these changes are going on below the surface, the skin, at first congested, becomes somewhat paler, and assumes a white or marbled appearance, rapidly forming into black sloughs, and being undermined to a large extent by large quantities of broken-up areolar tissue and of ill-conditioned pus, without any appearance of pointing, however extensive the subcutaneous mischief may be. These destructive changes expose muscles, fasciæ, and blood-vessels, and may induce necrosis of the bones or destroy the joints. They occur most readily in those parts of the body that possess the lowest degree of vitality, and hence are more common in erysipelas of the legs than in the same affection of the scalp. If the patient recover, there will be tedious cicatrisation of the deep cavities that are left, or considerable œdema, often of a solid character, a kind of false hypertrophy of the part, which may continue for some considerable time. In other cases, there may be such extensive local destruction or gangrene of the soft tissues, with exposure and death of the bones or suppuration of the joints, that amputation of the limb may be required to save the patient's life. No operation of this kind, however, should ever be practised for the effects of erysipelas, unless they be strictly localised, and without tendency to spread; nor until specific constitutional fever has been completely removed, except such as is of a hectic character, and dependent on the exhausting influences of the suppuration and disorganisation of tissues.

During the progress of these local changes, the *Constitutional Symptoms* have assumed corresponding modifications. At first of an active inflammatory character, the fever, when suppuration and sloughing have set in, often suddenly becomes asthenic. Although in some cases there is at first no diminution in the severity of the symptoms, the constitution gradually gives way after the patient has struggled for a few days against the exhausting influences of the disease, and death speedily supervenes. If the patient survive the stage of sloughing, and if the discharge continue abundant, hectic, with diarrhœa, gastro-intestinal

irritation, metastatic abscesses, or pyæmia, may carry him off. If recovery eventually take place it may be at the expense of a constitution impaired and shattered for years. This disease is most fatal in the old and infirm, or in young children. The immediate danger is always greatest when the head is affected, from the extension of the disease to the membranes of the brain, and the supervention of arachnitis. The remote danger from the effects of suppuration of areolar tissue, necrosis of bones, and inflammation of the joints, is greatest when the lower extremities are the seat of erysipelas.

A variety of the cellulo-cutaneous erysipelas has been described as **Œdematous Erysipelas.** By this is meant not merely the effusion into the areolar tissue which occurs in all the varieties of the disease, but a peculiar form, specially marked by œdema of the areolar tissue, with less inflammation of the skin than usual. There is much swelling, which pits deeply on pressure but with little pain or tension, and but moderate redness of the skin; the constitutional symptoms are less marked than in the other varieties of the disease; it is principally met with in old people, or in persons of a dropsical tendency, in whom it occurs especially about the legs, scrotum, or labia, sometimes giving rise by the effusion of a sero-plastic fluid, to permanent and solid enlargement.

3. CELLULAR ERYSIPELAS, or, as it is often termed, **Diffuse Inflammation of the Cellular Tissue**, or **Cellulitis**, has been particularly described by Duncan, Arnott, Lawrence, and Nunneley. It always arises from a wound or injury, often of an apparently trivial character, and most commonly affects the subcutaneous areolar membrane, though occasionally it extends to the subaponeurotic tissue, and then is a more severe and dangerous affection. Though commonly arising as a consequence of ordinary injuries, it is especially apt to follow those in which there has been any inoculation of animal poisons, as from dissection-wounds, the stings of insects, and the bites of venomous reptiles. In whatever way arising, it is characterised by the rapidity and extent of the sloughing of the affected tissue, and by great depression of the powers of the constitution. That the diffuse inflammation of the areolar tissue, whether it be limited to a finger, or implicate the areolar tissue of half the body, is a variety of erysipelas affecting this texture primarily, and the skin secondarily, there can be no doubt. The points of resemblance between cellulitis and erysipelas have been well shown by Nunneley. Not only are the local effects precisely the same in the two diseases —the swelling, tension, infiltration of pus, and formation of gangrenous shreds and sloughs—but the constitutional symptoms, though varying perhaps in degree, present no difference as to character. The results also are identical, there being the same local impairment of structure, the same tendency to involve parts at a distance, and to the formation of secondary abscesses. These two forms of disease occur in the same constitutions, in the same states of the atmosphere, and in the same situation; one may produce the other; and, lastly, the same treatment is required for both.

Local Signs.—There are great swelling, tension, and pain in the limb, which feels brawny in some parts, œdematous in others. The skin is slightly reddened in patches, has a mottled appearance, and speedily runs into blackish sloughs. The extent to which the disease may spread varies greatly; when once it has set in, it commonly runs rapidly up the whole of a limb, extending also to the sides of the trunk; in other cases, its violence appears to be principally expended at a distance from

the seat of injury; thus, in a case of a punctured wound of the finger, the diffuse inflammation may principally take place in the extended planes of areolar tissue about the axilla and sides of the chest. It is important to bear in mind that this form of erysipelas sometimes affects the internal planes of areolar tissue. This may happen, for instance, in the fasciæ of the pelvis after lithotomy, or in the anterior mediastinum after operations at the root of the neck. The sloughing often occurs with remarkable rapidity in the course of thirty-six or forty-eight hours, the areolar membrane being broken down into ill-conditioned pus and shreddy sloughs, more especially when the disease has resulted from the inoculation of an animal poison. Death may in such cases occur in two or three days; in other instances, several weeks may elapse before a fatal result declares itself.

The *Constitutional Symptoms* are those of asthenic fever in the most marked degree; a quick and feeble pulse, brown tongue, and muttering delirium, being early concomitants of this affection.

Post-mortem Appearances.—After death from erysipelas, the internal organs present nothing that is characteristic. As in all diseases accompanied by high fever and general blood-poisoning, the epithelium of the kidneys and liver is found in a state of cloudy swelling, and the spleen is in some cases enlarged. The lungs are usually congested. Sometimes marked post-mortem staining of the blood-vessels and organs is found very soon after death, and occasionally small petechiæ are scattered beneath the serous membranes. It has been lately stated by Lukowsky, that, at the advancing line of the rash in cutaneous erysipelas, the lymphatic vessels and spaces of the skin are found to be packed with minute organisms (micrococci), which are not present when the eruption is receding, or in the parts over which it has passed; but this assertion requires confirmation.

Diagnosis.—The diagnosis of the various forms of erysipelas is generally easily made. From the *exanthemata*, it is distinguished by the character of the eruption, its limited extent, and usual complication with injury. From *inflammation of the veins or of the absorbents*, the diagnosis is not always easy, more especially as the two conditions frequently co-exist. If it be a vein that is inflamed, the general absence of cutaneous redness, the existence of a hard round cord, and the tenderness along the course of the vessel, are sufficient to establish the diagnosis. In inflammation of the absorbents, the redness is not uniform, but consists of a number of small and separate red streaks, running in the direction of the lymphatics, and affecting the glands towards which they course. These two affections, however—erysipelas of the skin and inflammation of the absorbents—are almost invariably conjoined; hence a definite diagnosis is not of much importance.

Prognosis.—The prognosis in erysipelas is always grave. It may be dangerous to the part affected, or to the life. The cellulo-cutaneous variety is very dangerous to both; more especially if it be traumatic; if it affect the head or parts in which the areolar tissue is abundant and lax, as the scrotum and orbit. There may be special danger even in the slighter forms of erysipelas from the seat of the affection, or of asphyxia when attacking the fauces. One great cause of danger in erysipelas, and that renders it so depressing to the strength and so fatal a disease, is its constantly progressive tendency, so that whilst fading on one side it continues to extend on the other. No interval of time is thus left for constitutional rally, or for recovery of strength. The *form of the disease* influences greatly the result; the cutaneous variety being attended

with least danger, the cellular with the most. The danger in erysipelas will depend greatly upon whether the disease be *traumatic* or *idiopathic*. The traumatic is infinitely the most dangerous. This is probably due to the admission of air, and the accompanying organic matter, into the inflamed cellular tissue through the wound. The same condition, indeed, that renders an open wound much more dangerous than a subcutaneous one, renders traumatic infinitely more fatal than idiopathic erysipelas. Much also depends on the *seat of the affection;* that attacking the head and lower limbs being the most dangerous; encephalitis being apt to ensue, when the head is affected. When the legs are extensively implicated, sloughing of the skin and areolar tissue, with denudation of the bones and destruction of the joints, may occur. The disease in all its forms, is most dangerous at either of the *extremes of life.* If the *constitution* be sound, very extensive mischief may be recovered from; if, on the other hand, it be depressed or broken by want of the necessaries of life, by fatigue, over-exertion, or indulgence in stimulants, a very slight amount of disease may prove fatal. The most dangerous complication of erysipelas, and one which when it exists almost precludes the hope of recovery, is *chronic disease of the kidneys*, either in the form of the granular contracted, or of the large white kidney, with albuminuria. I have never seen any patient laboring under these diseases, and attacked with traumatic erysipelas, escape with life; the sloughing and suppuration running on unchecked by any treatment that could be adopted. The particular *type* which the erysipelas may assume, and the occurrence of gastro-intestinal or pulmonary complications, will also seriously affect the result.

TREATMENT.—**Preventive Measures.**—The occurrence of erysipelas is best guarded against by attention to hygienic measures, more particularly proper ventilation with pure air, and the avoidance of overcrowding of patients. In hospitals, erysipelas might be produced at any time by want of attention in these respects, and the frequency of its occurrence may most materially be lessened by careful regulation of the hygienic conditions that surround the patient. With every care, however, erysipelas can never be completely eradicated from surgical wards, as it is often epidemic, brought into the hospital from without, and in many cases the conditions that lead to its development have influenced the patients so deeply before there admission into hospital, that no subsequent attention can prevent its occurrence afterwards. It often happens that erysipelas is unusually frequent in certain wards and even in certain beds. Its persistence in these respects will be found to be owing to some local cause, such as the emanations from a drain or dust-bin, on the removal of which the disease will cease. Scrupulous attention to cleanliness also on the part of nurses and dressers should be enforced, and the latter should not be allowed to go straight from the dead-house to the ward without previously washing their hands in some disinfectant or antiseptic solution. When erysipelas has already occurred, its further spread may be prevented by isolating the affected patients, and at once taking active measures to purify the ward from which they have been removed.

The **Curative Treatment** of erysipelas must always be conducted with reference to the low character of the local inflammation, its tendency to run into suppuration and gangrene, the asthenic type that the constitutional fever readily assumes, and the frequent complication of visceral inflammations of a congestive form. The apparent intensity of the local inflammation must not lead the Surgeon into the fatal error of employing

an over-active antiphlogistic treatment, more particularly if the disease be epidemic, when it always assumes a low type. It is especially important to look to the future, and to remember that, if active depletory measures be employed early with a view of lessening the present disease, it will be at the risk of inducing more extensive sloughing, and perhaps of lowering the patient's powers to such a degree as to prevent his bearing up under the depressing influence of the ulterior consequences of the disease.

Treatment of Cutaneous or Simple Erysipelas.—The treatment required is essentially of a tonic and stimulating character. The principal medicinal remedies consist of bark, quinine, iron, and ammonia. If there be much thirst, these remedies may be given in an effervescent form. But in any case they should be administered in frequent doses. In many of the low forms of erysipelas, medicines are not well borne, the stomach rejecting them; and then I have seen the best possible results follow the free administration of the brandy-and-egg mixture, to which I am in the habit of trusting in the majority of these cases. During the progress of the disease, simple purgatives must be given from time to time. In anæmic and cachectic individuals no remedy exercises so beneficial an influence as the tincture of perchloride of iron, administered in doses of twenty minims every third or fourth hour.

The *Local Treatment* of this, as of every variety of erysipelas, is of equal importance with the constitutional management. In slight cases the part should be covered with flour or starch powder dusted over it. In the more severe forms warm applications assiduously continued, especially poppy and chamomile fomentations applied by means of flannels or spongio-piline, afford the greatest possible relief. Cold lotions should never under any circumstances be employed; they not only lessen the vitality of the part, and thus favor local sloughing, but they may chance to cause a retrocession of the disease, and the consequent affection of some internal organ. The local abstraction of blood and of serum from the inflamed part, by the plan introduced by Sir R. Dobson, of rapidly making with the point of a lancet a large number of small punctures, from a quarter to a half an inch deep, is of much value, by lessening the tension and swelling, and consequently diminishing the inflammatory action; a hot fomentation cloth or a poultice should be laid over the punctures so as to encourage bleeding, and the escape of serum. Astringent applications to the inflamed surface, such as a strong solution of the nitrate of silver, are recommended by some Surgeons. I have seen them rather extensively employed in former years, but not with any very marked success. A boundary line of nitrate of silver is occasionally drawn around the inflamed part, with a view of checking the extension of the disease. I have often done this, and seen it done by others, but never apparently with any benefit; and have now discontinued the practice as an useless source of irritation. If the disease have attacked one of the limbs, the application of a bandage is occasionally necessary after the disappearance of the erysipelas, in order to remove the œdema that remains, and to support the softened and weaker tissues.

In the **Treatment of Cellulo-cutaneous Erysipelas**, more energetic constitutional and local means are required. In the early stage, our object is to prevent the inflammation from running into gangrene of the affected tissue. The fever being at this period commonly sthenic, the more active administration of purgatives, antimonials, or effervescent salines is required. I have never seen a case in which blood-

letting was required; and depressing remedies, such as salines, should be given with great caution. Medicinal tonics and dietetic stimulants require to be given early and late. As the disease advances, and symptoms of more or less depression come on, it may be necessary to effect that gradual change to a more stimulating plan of treatment, which has already been described in speaking of the management of inflammatory fever. In doing this, the pulse and the tongue must be our guides; as the one becomes feebler and the other browner, so must ammonia, bark, and especially port wine, and the brandy-and-egg mixture, be administered. In the more advanced stages of the disease, when sloughing and suppuration are fully established, our sole object must be by nourishing diet, and the use of stimulants and tonics, more particularly the tincture of perchloride of iron, to bear the patient through the depression and subsequent hectic.

The *Local Treatment* of cellulo-cutaneous or phlegmonous erysipelas must be conducted on essentially the same plan as that of the cutaneous variety, though with more active means. The part affected must be kept at rest, must be elevated if it be a limb, and have hot chamomile and poppy fomentations assiduously applied, cold being more prejudicial here even than in the form of the disease last described; in this way, the swelling and tension may perhaps be removed, and the sloughing of the areolar tissue prevented. In the majority of cases, however, other means will be required to effect this, and with this view none are more efficacious than incisions made into the part; by these an outlet is afforded for the blood and effused serum, which by distending the vessels and cells of the part, produce strangulation of the tissues and consequent sloughing. This mode of practice, originally introduced by Mr. C. Hutchinson, is generally allowed to be the most effectual means we possess for the *prevention* of sloughing; hence the incisions should be made early, before there has been time for the tissues to lose their vitality. So soon, indeed, as they have become brawny, indurated, and tense, incisions properly made and placed will afford the greatest possible relief to that part and the patient, taking down the tension by the gaping, and the swelling by the exit they afford to blood and serum. Much difference of opinion has existed among Surgeons, as to the extent to which incisions should be practised in these cases; some recommending that one long cut should be made through the inflamed structures; others contending, on the contrary, that a number of small incisions better answer the proposed end. The objections to the long incision are, that so considerable a wound not only inflicts a serious shock to the system, but that the loss of blood from it may be so great as to be fatal —cases having occurred in which life has been lost from this cause, or the hæmorrhage has been arrested only by the ligature of the main artery of the limb; and also that a single long incision does not relieve tension so effectually as a number of smaller ones. These preventive incisions consequently should be of limited extent, from two to three inches in length: at most they should not extend deeper than into the gelatinous-looking subcutaneous areolar tissue, unless it happen that the disease have extended beneath the fascia, when they may also be carried through it. South recommends that the incisions should be so arranged in fours,

as to enclose a diamond-shaped space, and states that in this way the greatest relief is given to the tension of the part. After the incisions have been made, the part should be well poulticed and fomented, so as to facilitate the escape of serum. As it is not the object of the Surgeon to draw blood in these cases, any un-

due amount of hæmorrhage should be arrested by plugging the wound. Much blood may be saved by elevating the limb and applying a tourniquet before using the knife, but it is better not to employ Esmarch's bandage, for fear of driving the unhealthy inflammatory products into the circulation. In those cases in which the disease is not already complicated with an open wound and decomposing discharges, great advantage will be derived from the employment of Lister's antiseptic dressing, thus preventing the decomposition of the effused inflammatory fluids which fill up the areolar tissue exposed by the incisions. Before making the incisions, the limb should be well fomented for a quarter of an hour with cloths wetted with a hot solution of carbolic acid (1 to 40). The tourniquet is then applied, and the incisions made under a spray of carbolic acid. To arrest excessive bleeding, the wounds must be plugged with carbolic acid gauze. The treatment is then conducted according to the rules laid down when describing the antiseptic method. If the necessaries for Lister's dressing be not at hand, the part may be wrapped in hot oakum poultices, or dressed with some other disinfectant application. After suppuration and sloughing have taken place, as indicated by a boggy feel of the parts, free incision should be made in order to let out pus and sloughs. After this, the skin will often be found to be greatly undermined, blue, and thin, with matter bagging in the more dependent parts; if so, egress must be made for it by free counter-openings, and drainage-tubes inserted as required. During the after-treatment, frequent dressing is necessary to prevent an accumulation of pus, and the sloughs must be removed as they form. Care should be taken not to destroy any of the vascular connections of the skin with subjacent parts; but, in order to get proper cicatrisation, it will often be found necessary to lay open sinuses, or to divide bridges of unhealthy and blue integument stretching across chasms left by the removal of the gangrenous areolar tissue. If the loss of substance be great, the cicatrix that forms may be weak, imperfect, or so contracted as to occasion great deformity of the limb. In other cases, again, the diseased state of the bones and joints may be such as to call for ultimate amputation, either in consequence of the local deformity and annoyance, or in order to free the constitution from a source of hectic and of irritation. In all circumstances, the patient's health will usually continue in a feeble and shattered state for a considerable time after recovery from this form of erysipelas, requiring change of air and great attention to habits of life, a nourishing diet, &c.

In the **Treatment of Cellular Erysipelas** it is usually necessary to administer stimulants early; ammonia, wine, or brandy may be required from the very first. The Surgeon must judge of this by the constitutional condition of the patient, and more particularly by the state of his pulse and tongue. The *Local Treatment* is precisely of the same kind as that adopted in phlegmonous erysipelas, except that the incisions require to be made earlier and perhaps more freely; in all other respects, there is no difference between the general management of the two forms of the disease.

Special Forms of External Erysipelas.—**Erysipelas of Newly born Infants** is occasionally met with, more particularly in lying-in hospitals, or in situations where the mother and child are exposed to depressing causes of disease. It usually appears a few days after the birth, at first about the abdomen and genitals, and soon spreads over the whole of the body, being characterised by a dusky redness, which rapidly runs into gangrene of the affected tissues. It has been sup-

posed to arise from inflammation of the umbilical vein, or of the umbilicus itself. It is extremely fatal, owing to the feeble vitality of the child, and presents but few points for treatment; change of air and of nursing, with the administration of a few drops of spirits of ammonia or brandy from time to time, being all that can be done.

Erysipelas of the Orbit may occur primarily, or as the result of extension of the disease from the neighboring structures. It is dangerous, and often fatal from encephalitis. It commences with a violent deep-seated pain at the base of the orbit; the conjunctiva becomes injected and ecchymosed, the eyelids are greatly swollen, red, and œdematous; the eyeball protrudes, and vision is impaired or altogether lost. Symptoms of cerebral inflammation now set in, and the patient becomes delirious and often sinks comatose.

The *Treatment* consists in fomentations with early and free incisions into the orbit, made by pushing a lancet flat-wise between the eyeball and the orbital walls, through the inflamed conjunctiva, the eyelids having previously been everted. In this way inflammatory effusions and pus may be evacuated Destructive abscesses of the orbit, possibly of an erysipelatous origin, occasionally occur in the puerperal state, requiring, when practicable, the free evacuation of the pus, in the way just mentioned.

Phlegmonous Erysipelas of the Head is of very frequent occurrence from slight injuries or operations about the scalp and face, more particularly in elderly people and those of unhealthy constitution. In this form of erysipelas there are two special sources of danger; one is sloughing of the occipito-frontalis muscle, the other, inflammation of the membranes of the brain. The occipito-frontalis muscle rarely sloughs, except in cases of traumatic erysipelas of the head. It then loses its vitality in consequence of the suppuration of the deep plane of areolar tissue lying between it and the cranium, and encephalitis occurs apparently by the extension of the inflammation inwards.

The *Prognosis* of erysipelas of the head will often greatly depend upon its origin—whether traumatic or idiopathic. When arising from wound, it is very commonly fatal; when it is idiopathic, it is very seldom indeed followed by death. This difference in the termination of the two varieties of the disease is owing, I believe, to the great tendency to suppuration and deep sloughing of the scalp in cases of wound, and the infrequency of this occurrence when there is no breach of surface.

In the *Treatment* of this affection, active means are more frequently required than in the management of other forms of erysipelas. But in very many, perhaps I may say in most instances, the disease is associated with more or less asthenia, and then the tonic and stimulating plan of treatment is attended by the best results. With a view of preventing sloughing of the muscles, a free crucial incision should be made through the scalp down to the bone; the head, of course, having been shaved at the onset of the disease. Bagging of matter must be prevented by free counter-openings, and the application of pads and bandages, wherever it is likely to occur. However much the scalp may be undermined, or the bones of the cranium exposed, adhesion usually takes place, and the vitality of the parts is preserved.

Phlegmonous Erysipelas of the Lips and Side of the Face and Neck, of a peculiarly fatal character, occasionally occurs in young people otherwise apparently healthy. It begins with a pimple, bleb, or vesicle on the lips or nose. This is occasionally attributed to the sting of some insect, or possibly to inoculation from a carion-fly. It is hot,

painful, and itching; from this, as from a focus of mischief, the disease spreads rapidly, usually involving one side of the face only. The parts become brawny, red, and purplish, greatly swollen, and painful. The constitutional disturbance is very great. Irritative fever, rapidly assuming a low form, sets in; and death commonly results in from forty-eight hours to six days, recovery rarely occurring. This disease has some resemblance to malignant pustule, but never runs into suppuration or slough. Hence I do not think that it can justly be considered a carbuncular inflammation of the face, under which term it has been described. Its whole course and the appearance of the inflamed part rather indicates its erysipelatous nature. Death usually ensues in from forty-eight hours to five or at most six days after invasion. The fatal result is preceded by rigors, and is evidently due to blood-poisoning of a rapid and aggravated character. The infection of the blood takes place through the large venous anastomoses of the side of the face, which are peculiarly patent, occurring in the dense areolar and fibro-cellular structures in which they ramify. Treatment has little effect in staying the progress of this terrible malady. Dietetic stimulants, strong support, and tonics are indicated. Free incisions might be of service, but the situation affected prevents the possibility of their employment.

Diffuse Cellulitis of the Submaxillary Region has been specially described by Bickersteth. After the exposure to the heat and cold, great inflammatory swelling rapidly sets in at the forepart of the neck and under the angle of the jaw; these parts become diffusedly brawny; unless relief be afforded, death will rapidly ensue from suffocation, the disease spreading to the root of the epiglottis, and producing œdema glottidis.

The *Treatment* consists in making a free incision in the mesial line, from the chin to the os hyoides, through the infiltrated parts, from which a thin dark serum, but no pus, will be seen to exude. The incision must be carried to a depth of two inches or more towards the base of the tongue, keeping carefully to the middle line, until the whole of the brawny infiltration has been divided.

Erysipelas of the Scrotum, the "inflammatory œdema," so well described by Liston, is of frequent occurrence, as the result of wounds, ulcers, and other sources of irritation in this neighborhood. The scrotum swells to a large size, being uniformly red, but with a semi-transparent glossy appearance, pitting readily on pressure, and feeling somewhat soft and doughy between the fingers: the integuments of the penis are also greatly swollen and œdematous, and sometimes the inflammation extends to the areolar tissue of the cord. The chief characteristic of this form of erysipelas is its tendency to run into slough without any previous brawny or tense condition of the parts; the dartos becoming so distended with sero-plastic fluid that the circulation through it is arrested, and its tissue loses its vitality When an incision is made into it in this state it scarcely bleeds, and the sides of the wound present a yellowish-white gelatinous appearance.

The *Treatment* of erysipelas of the scrotum consists in making a free incision about four inches in length from behind forwards on each side of the septum, taking care, of course, not to go so deep as to wound the testes; the part must then be supported on a pillow, and well poulticed and fomented. If this incision be not made at once, a great part or even the whole of the scrotum may slough away, leaving the testes and cord bare; in these unpleasant circumstances, however,

the parts will often with great rapidity cover themselves with a new integument. The œdema of the penis usually subsides of itself, or after making a few punctures in it; should its integuments, however, threaten to slough, a free incision must be made into it, or the prepuce be slit up.

Erysipelas of the Pudenda is occasionally met with in ill-fed unhealthy children in whom cleanliness is neglected. The parts become of a dusky or livid red, swell considerably, and quickly run into gangrene, which spreads up the abdomen or down the nates. It may prove fatal by inducing peritonitis or exhaustion. In the *Treatment*, ammonia, bark, and the chlorate of potash, with good nourishment, and a little wine, are the principal means, at the same time that yeast or chlorinated poultices are applied locally.

Erysipelatous Inflammation of the Fingers, or, as it is commonly called, **Whitlow**, is a frequent affection in old and in young people, either occurring spontaneously in cachectic constitutions, or as an accompaniment of renal disease, or arising from the irritation produced by scratches, punctures, or the inoculation of the part with poisonous or putrescent matters. It is most common in the spring of the year, when, indeed, it sometimes appears to be epidemic.

That whitlow is truly an erysipelatous affection of the fingers, appears to be proved by the following facts 1. The causes, whether of season, infection, or local irritation, are the same in both affections. 2. The constitutional disturbance in whitlow is always very severe for a disease apparently so slight, and assumes the same character of speedy depression that we observe in erysipelas. 3. The inflammation of the affected finger is invariably diffused, never being bounded by adhesion, but always tending to terminate in suppuration and sloughing. 4. So soon as the disease spreads beyond the affected finger, or to the back of the hand, it assumes a distinctly erysipelatous appearance and character.

The inflammation of whitlow is in many cases confined to the pulp of the finger, commencing in the dense cellulo-fibrous tissue forming this, and often arising from a very slight injury, as the prick of a pin, splinter, but not unfrequently without any recognisable traumatic cause. The part becomes extremely painful, hard, red, and swollen: it then suppurates to a limited extent, with some sloughing of the areolar tissue. In many cases the ungual phalanx, which is embedded in the cellulo-fibrous pulp, necroses. There is usually some inflammation of the lymphatics of the arm; and not unfrequently a good deal of constitutional fever and irritation is present.

In the more severe cases of whitlow, the inflammation, which is of an excessively painful character, owing probably to the tension of the parts, extends to the sheaths of the tendons, and then constitutes an affection that is fraught with danger to the utility of the finger or hand. The whole finger swells considerably, becomes red and tense, with much throbbing and shooting pain; the inflammation rapidly extends to the back of the hand, which becomes puffy, red, and swollen, presenting the ordinary characters of erysipelas. Although the palm be greatly swollen, it usually preserves its natural color, or becomes dull white, owing to the greater thickness of the cuticle. Pus rapidly forms, both in the finger and hand, and, finding its way into the sheaths of the tendons, spreads up the fore-arm under the annular ligament. There is usually no fluctuation to be felt in the finger, even though pus may have formed, but in the other parts of the hand it may readily be detected in the usual way. In these cases there is always much sloughing conjoined

with the suppuration; the areolar tissue of the fingers and hand, the tendons of their sheaths, and the palmar fascia being all more or less implicated. In some cases the end of the finger, as far as the first phalangeal joint or the middle of the second phalanx, falls into a state of gangrene and has to be separated. In many cases the joints of the fingers are destroyed, and the phalanges necrose; or, if this do not happen, the tissues of the part may be so matted together, as the result of sloughing and suppuration, that rigid and contracted fingers, or a stiff and comparatively useless hand, may be permanently left. Whitlow affecting the little finger or thumb is much more likely to cause suppuration in the common sheath of the flexor tendons than when it occurs in any of the other fingers. This is due to the fact that the synovial sheaths of the flexor tendons of the thumb and little finger communicate with the common sheath, while those of the three other fingers do not.

In the *Treatment*, the patient should be well purged, and kept upon a strictly antiphlogistic regimen during the early stages. At the same time the inflamed finger should be freely leeched, and then alternately poulticed and soaked in very hot water, for twenty-four or forty-eight hours, being kept during the whole of this time in an elevated position. In this way the inflammation may be sometimes cut short at its onset; should it, however, continue to increase, the finger becoming hard, with much throbbing, a free longitudinal incision must at once be made along each side of it, so as to relieve tension and prevent sloughing; this procedure should never be omitted, on account of the importance of the preservation of the full utility of the part. Local anæsthesia of the finger may be produced by the ether-spray. The incision is best made from the proximal towards the distal end of the finger, so that, if the patient withdraw the hand it will, as it were, meet the knife, and the operation of cutting will be facilitated rather than prevented. In making these incisions, the sheaths of the tendons should, if possible, be avoided; if they be opened, the tendons will probably slough, and the finger be left in a permanently extended and rigid state. The finger must then be well soaked in hot water, and poulticed. In this way the inflammation may be arrested, and sloughing happily avoided; should, however, matter have formed, it must be let out as it accumulates. The dead and sodden cuticle should be cut away with scissors, as it frequently seriously interferes with the escape of the discharges and sloughs. After the opening has been made, and any slough which may have formed has come away, it not unfrequently happens that a large and fungoid granulating mass spouts up; this will, however, gradually subside, as the swelling of the finger goes down and the inflammation abates. If the nail become loosened, it had better be removed, as it may otherwise keep up irritation; it must not, however, be torn off if adherent, but merely scraped and cut away so far as it is loose. When the whole of a finger is affected, the hand should be placed on a pasteboard splint as soon as the inflammation has been somewhat subdued, lest contraction of the affected finger ensue, which may eventually extend to the neighboring ones.

In opening a deep seated palmar abscess, there is danger of wounding the branches of the median nerve, the superficial palmar arch, and the digital arteries. These structures may all be avoided, and the operation done safely, by making the incision towards the head of a metacarpal bone, upon the bone itself and parallel to its axis, so as to avoid the digital interspaces.

When the joints are implicated, destruction of the cartilages commonly

ensues; yet, by position, and rest on a splint, a tolerably useful though stiffened finger may be retained. When the bones are implicated, some operative procedure usually becomes eventually necessary. If the ungual phalanx alone be necrosed, it may be excised through an incision on the palmar side of the finger, the pulp and nail being left; in this way I have often preserved a finger that must otherwise have been removed. Amputation of the finger at the metacarpo-phalangeal articulation will usually be required when the second or proximal phalanges are involved, though here partial excision, by cutting and scraping away the diseased bone, may sometimes be usually done. During the later stages of these affections, tonics, good diet, and stimulants will be required for the re-establishment of the health.

INTERNAL ERYSIPELAS.

By **Internal Erysipelas** we mean those forms of diffuse inflammation which effect the Mucous or Serous Surfaces, or the Lining Membrane, of Arteries, Veins, and Lymphatics.

Erysipelas of Mucous Surfaces.—The mucous tract that is chiefly affected by this disease is that covering the fauces, the pharynx, or the larynx.

Erysipelas of the Fauces may occur in consequence of the disease spreading from the head and face to these parts; or it may commence as a primary affection, occurring perhaps at the same time that the rash appears on the cutaneous surface of some distant part of the body. When the fauces are erysipelatous, they present a bright crimson or scarlet color, with some swelling and thickening of the soft palate and uvula; the patient also most commonly has some huskiness or complete loss of voice, and occasionally some croupy symptoms. At the same time there is a good deal of low constitutional fever, with a pungent hot skin and quick pulse. This form of erysipelas is peculiarly contagious, and occurs not unfrequently in the attendants or those who are laboring under some of the other varieties of the disease; of this I have seen numerous instances. In many cases, also, it is epidemic, spreading through a house and affecting almost every inmate.

Treatment.—The best results are obtained by sponging the inflamed parts freely with a strong solution of the nitrate of silver; and, if there be much constitutional depression, by administering full doses of ammonia, with camphor or bark. Should the disease go on to sloughing, constituting one of the forms of "putrid sore throat" (which not unfrequently happens), the mineral acids and barks, with chlorinated gargles, and the brandy-and-egg mixture for support, will be found most useful. In many cases, this disease continues limited to the palate and fauces; but in others it extends upwards or downwards. It may extend upwards through the nares, out of the nostrils, and thus spread over the face and head. It may extend downwards, affecting the gastro-intestinal membrane, or, more frequently, implicating the larynx.

Erysipelatous Laryngitis, as described by Ryland, Budd, and others, is extremely dangerous. The inflammation, commencing in the fauces, rapidly spreads to the mucous membrane and loose submucous areolar tissue external to and within the larynx, giving rise to extensive œdematous infiltration with sero-plastic fluid, which, by obstructing the rima glottidis, may readily suffocate the patient. In consequence of this special tendency to œdema, the disease has by many writers been termed "*œdematous laryngitis.*" After death, the submucous areolar tissue of

the fauces, that about the base of the epiglottis, and especially that which enters into the arytæno-epiglottidean folds and that covering the posterior part of the larynx, will be found to be distended with serum or a sero-puriform fluid. This infiltration reaches to the rima of the glottis, and, extending into the interior of the larynx, gives rise to such swelling that its cavity is nearly obliterated. Great as the swelling may be, however, in all these parts, it never spreads below the true vocal cords. This fact, which is very important, is explained by the mucous membrane coming close into contact with, and being adherent to, the fibrous tissue of which these structures are composed, without the intervention of any submucous areolar tissue. The progress of this œdematous inflammation of the mucous membrane and loose submucous tissue in these situations, is often amazingly rapid, the swelling being sufficient to induce suffocation at the end of thirty-six or forty-eight hours, or even sooner. If the patient be not carried off in this way, there will be a great tendency to suppuration and sloughing of the affected tissues, leading perhaps eventually to death from absorption of pus and low constitutional fever.

The *Symptoms* of this affection are strongly marked. The patient, after being attacked with erysipelas of the fauces, attended by some difficulty and pain in deglutition, and huskiness of the voice, is seized with more or less difficulty in breathing, coughs hoarsely and with a croupy sound, and complains of tenderness under the angles of the jaw and about the larynx. The difficulty in breathing increases, and may speedily threaten the life of the patient, giving rise to intense fits of dyspnœa, in one of which he will probably be suddenly carried off. The difficulty is greater in inspiration than in expiration, as the swollen parts above the opening of the larynx fall together like a valve in the former act, while they are easily separated by air coming from below in the latter. On examining the throat the fauces will not only be observed to be much and duskily reddened, but by depressing the tongue the epiglottis can be felt, and perhaps seen, to be rigid and erect. Examination with the laryngoscope readily shows the condition of the parts to be as above described. Enlarged lymphatic glands can usually be felt early in the case, behind the angle of the lower jaw.

In the *Treatment*, local means are of the first importance. The tongue having been well depressed, the posterior part of the larynx, the epiglottis, and the arytæno-epiglottidean folds must be well scarified by means of a hernia-knife, with which this operation may be most readily and safely done. If no better instrument be at hand in case of emergency, a very useful amount of scarification may be done by the nail of the Surgeon's index-finger, notched with a knife to make it tear the mucous membrane more readily. The patient should then be directed to inhale the steam of hot water, and a large number of leeches may be applied under each angle of the jaw, to be followed by large and hot poultices; at the same time, the bowels must be kept well opened, and the patient treated by antiphlogistic measures or otherwise, according to the condition of the constitutional fever. Most frequently, I have found antimonials of great service in the early stages, followed later by support and stimulants. A few hours after the engorged tissues have been unloaded by scarification, the fauces, pharynx, and upper part of the larynx should be well sponged out with a strong solution of the nitrate of silver (sixty grains to an ounce) which must be applied freely, coagulating the mucus, and taking down the increased vascular action. If notwithstanding the employment of these measures, the dyspnœa

increase, the face becoming pale, livid, and bedewed with a clammy perspiration, it will be necessary to open the windpipe to save the patient from impending suffocation. In doing this I prefer laryngotomy, for reasons that will be mentioned when I come to speak of the Diseases of and Operations on the Air-passages. In order, however, that this operation may be successful, it must not be too long delayed, and should not be looked upon as a last resource; if it be done in time (and time in these cases is most precious, owing to the rapid progress of the disease), the patient's life may probably be saved; but if it be deferred too long, congestion of the lungs will come on, the blood will cease to be properly arterialised, and the patient will sink from slow asphyxia, even though air be at last freely admitted. If the patient survive to the stage of sloughing, chlorinated gargles, bark, and support must be our chief reliance.

Erysipelas of the Serous Membranes is of common occurrence in surgical practice, being frequently met with in the arachnoid and peritoneum. These, like all other serous membranes, are liable to two distinct forms of inflammation: one, which is sthenic, having a tendency to the formation of plastic lymph; the other, which is diffuse or erysipelatous, being always accompanied by the exudation of a plastic unorganisable material.

Erysipelatous or **Diffuse Arachnitis** commonly occurs as a consequence of injuries of the head and erysipelas of the scalp. There is usually a flushed countenance, with bright staring eyes, and low muttering delirium, followed by a comatose condition rapidly terminating in death; the constitutional symptoms are those of low irritative fever. On examination after death, the arachnoid and pia mater are found greatly injected with blood, forming a close red net-work of vessels over the surface of the brain; the substance of which is usually somewhat injected, the ventricles being distended with a reddish-colored serum. If examined at a later period in the disease than this, the inflamed arachnoid is found to be covered with a layer of opaque puriform lymph, of a greenish-yellow color and slimy consistence.

Erysipelatous or **Diffuse Peritonitis** is not unfrequently met with in aged and cachectic subjects after the operation for hernia, or as a consequence of various diseases and injuries of the pelvic or abdominal organs. The symptoms are often of a latent character, the disease being chiefly indicated by obscure pain diffused over the abdomen with tenderness on pressure, an anxious depressed countenance, and a small and rather hard pulse. There may be heat of skin; but it is a peculiar feature of this form of the disease that the patient may die without any elevation of the temperature of the body. On examination after death, the subperitoneal areolar tissue is found injected, the peritoneum opaque in parts, covered with filmy patches of greyish lymph, and usually containing a largish quantity of opaque dirty-looking turbid fluid, mixed with shreds and flocculi of lymph. This, though closely resembling pus in appearance, is serum with lymph intermixed, and is peculiarly acid, acrid, and irritating. It is this form of peritonitis that is especially dangerous to dissectors; inoculation of the fingers with any of this fluid being often productive of the most serious and even fatal consequences.

Erysipelas Inflammation of the Lining Membranes of the Vascular System will be discussed when we come to consider diseases of these parts.

CHAPTER XXXIII.

PYÆMIA.

THE term **Pyæmia** is applied to a group of pathological phenomena, which, arising in somewhat similar conditions, and running for the most part similar courses, were until recently considered to constitute a single well-defined affection dependent, as was supposed, upon the admixture of pus with the blood; hence the name given to it. This disease (for it will be found convenient, though not strictly correct, to look upon the members of this group as constituting but one affection) is closely allied in cause and in character to some of the lowest and worst forms of erysipelas and diffuse inflammation, with which indeed it is frequently associated, and to which it presents great similarity in its causes, symptoms, and effects.

CAUSES.[1]—Like erysipelas, pyæmia commonly occurs at those seasons of the year, and under those atmospheric conditions, in which diseases of a low type are prevalent. There is no more common or certain cause of its production than the overcrowding of patients suffering from suppurating wounds in hospitals; and it is in unhealthy and cachectic constitutions that it usually manifests itself. It is more common in adults and elderly people than in children; but, though it is least frequently met with during the earlier periods of life, it may make its appearance at any age. Very young children and even infants may be attacked by it.

Pyæmia is a very common cause of death after operations and severe injuries, especially in hospitals that are situated in large towns, or that, however well situated, are overcrowded. It is disposed to by all conditions of life, either before or after operations or injuries, that tend to impair the health, to lower the strength, and to induce an unhealthy state of the blood, such as constant want of fresh air, overcrowding in working or in sleeping apartments, and insufficient or improper nourishment. Of all these causes, overcrowding is undoubtedly the most frequent and the most fatal; more particularly is overcrowding of patients injurious, if there be many suppurating wounds under the same roof. That pyæmia is the result of the faulty hygienic conditions just alluded to, viz., want of pure air, overcrowding, and insufficient and unwholesome diet, is evident from the fact of its being rife and most destructive where those causes of disease prevail, as amongst the poorer classes of all large and densely populated towns; while in the purer air of country districts, or in private practice amongst the wealthier classes, it is rarely met with. It is one of those causes of death after operations that might and ought to be prevented; and wherever it is frequent, we may be sure either that the constitutions of the patients are peculiarly deteriorated, or else that the hygienic conditions to which they are exposed after the injury or operation are peculiarly faulty. That it may be prevented, has been abundantly proved by the experience gained in the Franco-

[1] See also Chapters I. and II., and "Hospitalism and the Causes of Death after Operation." Longmans, 1874.

German war of 1870. In that great struggle, the fact, which had been previously well known to all scientific Surgeons, was established beyond all possibility of cavil, that the danger of pyæmia increased, *cæteris paribus*, in proportion as wounded patients were closely crowded, so that the atmosphere surrounding them became contaminated by morbid exhalations from suppurating wounds. It was found in numerous instances that, among the great mass of the wounded, pyæmia was developed among those who were aggregated within the walls of hospitals of regular buildings, such as churches, barns, school-houses, and conservatories, which, though clean and airy, did not admit of thorough ventilation; while it was almost, if not entirely, unknown among soldiers of exactly the same class who were treated for wounds in hastily constructed open and draughty huts Indeed, there is no fact better established in surgery, than that pyæmia is the invariable result of the aggregation of the wounded, and that its development may be prevented at any time by reference to the cubic space allotted to each patient. As this is diminished, so the disease increases; and this, *cæteris paribus*, in an exact ratio.

Pyæmia is rarely, if ever, idiopathic or primary, but occurs as the consequence of previous inflammation of some part of the body. This inflammation may be idiopathic or the result of some wound or injury, and in most cases it has reached the stage of suppuration before the pyæmic symptoms come on. Cases, however, have been met with presenting all the *post-mortem* appearances of pyæmia, in which no local source of infection could be discovered after the most careful search. These are very rare, and do not prove that pyæmia can occur idiopathically; for, however careful a search may have been made, it is quite possible that the source of the disease was overlooked. Pyæmia frequently appears in connection with some low form of specific suppurative inflammation. Thus we see boils, carbuncles, diffused abscess, erysipelas of the skin, or erysipelatous inflammation of the veins or absorbents, precede and lead to its occurrence. In the vast majority of cases of pyæmia, coming under the observation of the Surgeon, the disease arises in connection with decomposing discharges from a wound. That is to say, at the time when the first rigor attacks the patient, the wound will be found to be yielding discharge having the odor of decomposition more or less distinctly perceptible. This fact, and the results of pathological experiments on animals, have led many Surgeons to believe that the absorption of putrid matter from a wound and its introduction into the system by means of the veins in the form of decomposing clots, is sufficient to give rise to all the symptoms of pyæmia, and that by the absolute prevention of decomposition in wounds, we may greatly diminish, in fact, almost abolish this disease. The influence of decomposition as a cause of pyæmia has been denied, because cases undoubtedly occur in which no decomposition is present at the source of infection. This, however, only shows that other poisons besides the products of putrefaction are capable of producing the series of symptoms which we call pyæmia. This matter will be discussed more fully under the pathology of the disease. Pyæmia is especially apt to occur, if decomposing pus be confined deeply amongst the tissues and unable to get a ready outlet. Wounds of veins, of bones, and of joints, are the injuries that are especially apt to be followed by this disease; and in the puerperal state it is often met with, probably as the result of uterine phlebitis.

PHENOMENA.—Pyæmia is characterised especially by two series of phenomena: 1. A peculiar train of Constitutional Symptoms attended

by a state of great depression of the powers of the system; 2. The formation of Abscesses, and the occurrence of diffuse inflammation in various parts of the body. The disease may be acute, subacute, or chronic. Most usually it is subacute, and often chronic. Whatever form it may assume, the symptoms are essentially the same, differing only in degree.

1. **Symptoms.**—The characteristic symptoms of pyæmia consist of a sudden and severe rigor, preceded by a great rise in the temperature of the body, and followed by profuse and exhausting sweating.

The invasion of the disease is as follows. During the period of an apparently ordinary febrile disturbance, the patient is seized with a rigor, usually very severe and prolonged. This is accompanied by a great rise in the temperature of the body, and is followed by profuse sweating, during which the temperature falls. The temperature again rises even as high as 107° Fahr.

The accompanying diagrams (Figs. 268, 269), for which I am indebted to Dr. Ringer, who took them from patients of mine, will indicate this more clearly than any description.

A single rigor only may occur, and the disease pass off. But more frequently the rigors are repeated at intervals of from 24 to 48 hours; and, as the disease becomes established, they may recur twice or oftener in the 24 hours.

The *temperature* in pyæmia presents remarkable and characteristic fluctuations. It is uniformly higher than normal, but rises above and falls in its general level in exact accordance with the development of the rigors. Wunderlich observes that the rise of temperature in the first accession of pyæmic fever is greater in a shorter time than in any other disease, and that the fall is equally rapid with the rise, and sometimes more so. But it does not, as a rule, reach the normal point, and usually ascends again long before this is reached. In some cases, however, the temperature falls slightly below normal during the profuse sweating following a rigor, as shown in the accompanying temperature charts. Dr. Ringer, who has paid great attention to this subject, believes that the rise in the temperature precedes the occurrence of the rigors; and he has been able to predict the approach of a rigor by noting a commencing rise in the thermometer. It is a remarkable circumstance that this actual and great increase in the temperature of the body should co-exist with a sensation of cold; and there are sometimes actually two rigors during one continuous rise of temperature.

As the rigor subsides the patient breaks into a sweat—first about the face and head, and then over the body. The sweats are usually very profuse, the bedclothes being soaked with perspiration. They are very exhausting to the patient. As soon as sweating comes on, the temperature begins to fall, and continues to decline until it reaches the uniform level, perhaps sinking in the earlier rigors to the normal level or even below it. This low temperature, when it occurs, is of very brief duration.

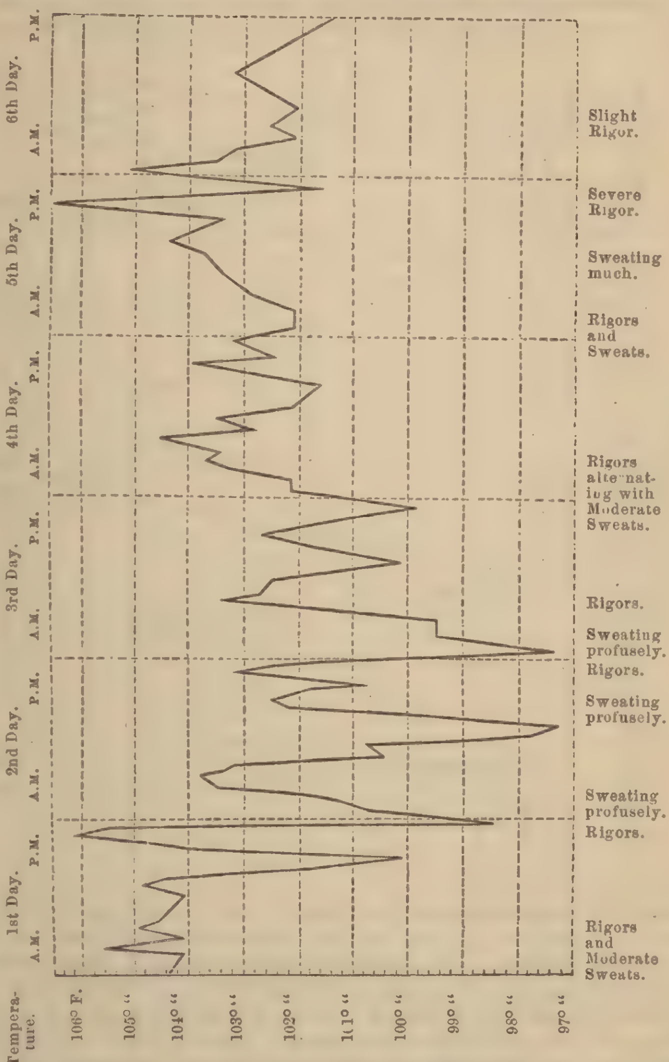
The heat, rigor, and sweating, increasing at pretty regular intervals, cause an invasion of pyæmia closely to resemble that of an ague fit. And, indeed, there would appear to be a close analogy between the two diseases; for, as ague is the result of blood-poisoning from exposure to malarial influences and the introduction into the system of peculiar products of vegetable decomposition, or, if Salisbury be right, of vegetable organisms of a low grade, so pyæmia is the effect of contamination of the blood by the absorption into, or the admixture with it, of organic

materials in a state of change that renders them capable of exercising a toxic influence on the body generally.

After the occurrence and repetition of heat, rigor, and sweating, other changes begin to manifest themselves.

Fig. 268.

Temperature Table in a case of Pyæmia following Primary Amputation of the Foot in a man aged 30.

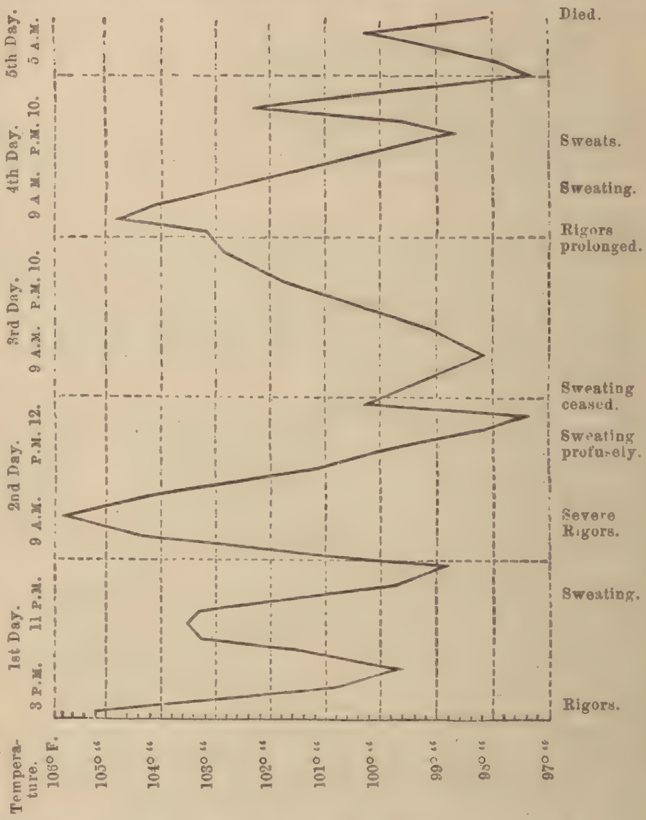


Any open wound that may exist at this time usually becomes foul and sloughy, and ceases to secrete healthy pus; but this is by no means necessarily the case, for it may continue healthily granulating throughout the disease. The skin is continuously hot, and has often a burning pungent feel. The breath has that peculiar sweetish, saccharine, or fermentative smell that is commonly noticed in all febrile diseases of a low type; this odor of the breath, and indeed of the body generally, often occurs early in the disease, and must then be taken almost as a

diagnostic and certainly as a most unfavorable sign. The secretions are arrested; the pulse is quick and soft; the face is usually pale, with a very anxious drawn look, but sometimes flushed, and the eyes bright; there are hebetude and dulness of mind, with slight nocturnal delirium, but perfect consciousness on being spoken to. Rapid wasting of the body sets in about this period; patches of erratic erythema frequently

Fig 269

Temperature Table in a rapidly fatal case of Pyæmia following a Compound and Comminuted Fracture of the Bones of the Leg.



make their appearance on the surface; and the skin assumes a dull sallow and earthy, or a bright yellow icteric tint, which may extend even to the conjunctivæ. The symptoms now indicate an extreme depression of the vital powers; the pulse becoming small and fluttering, the tongue, which has been dry, becoming brown, sordes being deposited about the teeth, and low delirium supervening. Usually from the sixth to the tenth day, but sometimes earlier, suppuration commences in different tissues, joints, and organs. Abscess may form in the lungs or pleuræ without cough or pain; if in the areolar tissue, or in the substance of muscles, there is usually doughy swelling, with some redness; if in the joints, the swelling is often considerable, the pain usually intense and very superficial and cutaneous, the patient screaming aloud with the agony. These pains, which are chiefly seated in the knees, ankles, hips, and shoulders, often simulate rheumatism very closely, and have been mistaken for that disease.

The progress of the disease is usually from bad to worse, sometimes rapidly, but at other times not uninterruptedly so, there being remissions, and apparent, though not real, improvement. The patient rapidly wastes, the body becoming shrunken, the muscles soft, and the skin grey or sallow, loose and pendulous; great debility also sets in. The abdomen becomes tympanitic, diarrhœa or profuse sweats come on; pneumonia or pleuritic effusions declare themselves; delirium, from which the patient is easily roused, alternates with sopor; and at last he sinks from exhaustion. Death usually takes place about the tenth or twelfth day; though it may occur as early as the fourth, or the patient may linger on for six or seven weeks.

In other cases pyæmia occurs in a very insidious manner, either without any rigor or with one so slight as hardly to be noticed. Occasionally the rigor may be more distinct, but in this variety of the affection it is never repeated during the course of the disease. It seems, in fact, little more than an exaggeration of the pre-existing surgical fever. The temperature remains high, showing, perhaps, slight fluctuations, but never presenting the extreme variations seen in ordinary pyæmia. There are complete loss of appetite and rapid wasting; occasionally diarrhœa is present, and more rarely vomiting. The tongue is extremely dry and furred, so as to render the patient's speech thick and unintelligible. After a time the skin assumes a yellowish tint, as do the conjunctivæ. This color is not due to true jaundice, but rather to an alteration in the blood, in consequence of which the red corpuscles break up during life, thus staining all the tissues of the body with their pigment. In acute cases, after from three to six days, the temperature falls, the pulse becomes more and more feeble, and the patient sinks into a semi-comatose state, in which he dies. If life be prolonged for a longer time, symptoms of low pneumonia or pleurisy, and, perhaps, pericarditis set in; abscesses may form in some of the joints, or in the seat of recent injuries or points of pressure, as over the backs of the arms, shoulders, or sacrum; and the patient gradually emaciates and dies exhausted. In these more chronic cases, the staining of the skin is not noticed. Many writers describe the above conditions under the name of septicæmia, and would distinguish it from pyæmia as a distinctly separate, although nearly allied, condition, reserving the name pyæmia for those cases in which metastatic abscesses distinctly referable to embolism are to be found. No doubt many cases are seen presenting every possible stage between the most typical specimens of the two varieties, and this has been used as an argument in favor of their identity; but it might also be explained by supposing that the two conditions may exist at one time mingled with each other in varying proportions.

2. The **Formation of numerous Purulent Deposits,** "secondary or metastatic abscesses," as they are often termed, is the most marked feature of pyæmia. The suppurations usually contain a somewhat thin and oily-looking pus; sometimes, however, it is thick and laudable. The more oily-looking fluid, though opaque and yellow, and closely resembling true pus, will, on microscopic examination, be found to differ from this in the absence of the true nucleated pus-corpuscles, though it contains an immense number of granular cells (Fig. 72). After removal it often forms a firm fibrinous coagulum. These purulent collections vary greatly in size and in situation. They are found in four localities, viz., in the viscera, in the areolar and muscular structures, in the serous membranes, and in the joints. They are most frequently met with in

the lungs and pleuræ, usually in one pleural sac only; then in the joints: next in the intramuscular areolar planes.

Pyæmic abscesses differ from ordinary purulent collections, not only in the peculiar character of the pus that they contain, but more particularly in the rapidity with which they form, a few days commonly sufficing for them to attain a large size. This, with their very widely spread character, and the insidious manner in which they occur, often with few if any local signs—the tissues, as it were, breaking down without any inflammation—constitute the distinguishing features of these collections.

The visceral abscesses vary in size from a pin's head to a walnut; in many cases the organs affected are studded with them. These collections are most frequently met with in the lungs, being seated at the posterior part and on the surface of these organs, or in the interlobular fissures; they are usually surrounded by a darkly inflamed and condensed layer of pulmonary tissue, and sometimes a zone of pulmonary apoplexy can be recognised immediately in contact with the puriform fluid. Not unfrequently they are seated in the midst of a large patch of lung in a state of low or congestive pneumonia, or the whole of the posterior part of the lung may be in this condition studded with small pyæmic abscesses. The organ that is most frequently affected next to the lung is the liver. Here, also, the abscesses are usually small, numerous, and surrounded by an inflamed or congested areola of hepatic substance. In some cases, however, hepatic pyæmic abscess is single and of considerable size, perhaps as large as an orange. I have seen purulent collections in the spleen; but they are rare here, in comparison to the organs just named. They may occur in other organs; as in the prostate, testes, and brain.

When the pus is infiltrated into the areolar tissue and muscles of the limbs and trunk, it forms immense diffuse collections of a thin serous matter, commonly mixed with shreds of the areolar membrane of the part, having no boundary of limiting fibrine. These collections are most frequent, perhaps, in the axilla, down the flank and about the back, in the iliac fossa, thigh or calf, and may either be confined to the subcutaneous, or extend to the deep intermuscular, areolar planes in these regions; or they may even form in the muscular substance itself, being diffused between the fasciculi, which are softened and disintegrated. Most commonly the presence of these collections is indicated by patches of cutaneous or erratic erysipelas, and by a doughy, œdematous, and boggy state of the superjacent integuments.

Accumulations of pus and deposits of lowly organised lymph in and upon the serous and synovial membranes are very common; the pleura, the arachnoid, or the peritoneum may each be thus affected. In the pleura, especially, these accumulations are frequent, and pyæmic empyema will often occur very suddenly with few, if any, general symptoms or local signs to indicate its presence. It is then most frequently due to extension from a pyæmic abscess immediately beneath the pleura, or perhaps, to rupture of such an abscess into the pleural cavity. Frequently some of the joints, especially the knees and shoulders, become filled with a thin, yellow, purulent liquid. These arthritic abscesses are usually indicated by intense pain, often cutaneous or superficial, with fluctuation and swelling in the joint. Often, however, large accumulations of pus form suddenly in joints, without having been preceded by pain or any other sign of mischief; in these cases the interior of the joint, though filled with pus, remains tolerably healthy, there being no

erosion of cartilage or destruction of ligament, but merely some inflammatory injection of the synovial membrane.

Not only are the appearances just mentioned commonly met with in cases of death from pyæmia, but we find inflammation of the viscera, more particularly of the brain and lungs, and not unfrequently a diffused erysipelatous redness of some membranous surface, as of the arachnoid or the gastro-intestinal mucous membrane. It must, however, be remembered, that in cases in which during life the skin has shown a marked yellowish tint, dark red *post-mortem* staining, not only of vessels but also of the tissues surrounding them, will always be found very soon after death, often before the body is cold, and this must not be mistaken for the results of inflammatory congestion.

Diagnosis.—The diagnosis of pyæmia requires to be made:—1, from ordinary Surgical Fever, the Inflammatory Fever which accompanies wounds and injuries, and Typhoid Fever; 2, from Ague; 3, from Rheumatism.

1. The **Diagnosis from ordinary Surgical Inflammatory Fever and Typhoid Fever** is usually sufficiently easy, the course of these fevers being unbroken by severe rigors, by sudden fluctuations of temperature, or by sweats. These symptoms, which are characteristic of pyæmia, do not occur in these other forms of febrile disturbance. An ordinary fever may be ushered in by a rigor; but this is seldom so intense as that which marks pyæmia, and certainly does not recur during the attack. The temperature also in ordinary fevers is uniformly and continuously high. It is not marked by those sudden exacerbations, followed by equally rapid declines, that are so characteristic of pyæmia. But it must be borne in mind that a pyæmic rigor may occur in the midst of the uniform high temperature of simple inflammatory fever, indicating the development of the blood-poisoning; but then the decline is only to and not below the previous high level, and, unless the pyæmia become established, the rigor and rise of temperature do not recur.

2. From **Ague**, which is indeed a form of blood-poisoning from vegetable decomposition, the diagnosis would not be easy in the earlier stages, if the patient had been exposed to malarial influences as well as to the ordinary causes of pyæmia, as in a person injured whilst living in a swampy country. But, in large towns, the general absence of ague and the obvious surgical cause of the pyæmia will render the diagnosis more easy. In the later stages, the signs of articular inflammation and suppuration, the secondary visceral and areolar abscesses will all tend to clear up the diagnosis.

The temperature will also serve as a valuable guide in forming a diagnosis. As before stated, in pyæmia it rarely falls to normal, and if by chance it do so, it rapidly rises again to a higher point, while in ague there is a very distinct and prolonged interval of normal temperature between the febrile attacks. If, however, the patient be suffering at the same time from ague and traumatic fever, the temperature will fail to sink to the normal point and the diagnosis will consequently be more obscure.

3. From **rheumatism** it is easy to make the diagnosis of pyæmia, provided the recurrent rigor and other early symptoms have been well and strongly marked. But if these have been somewhat obscure, and if the secondary articular implication be early developed, then it may certainly be difficult to determine the exact disease with which the patient is affected. But, independently of the recurrent rigor, the great prostration, the early supervention of atonic symptoms, the development of the visceral abscesses, of areolar suppuration, and of patches of

erratic erysipelas, will establish the true nature of the disease. Moreover, the temperature of rheumatic fever does not show the extraordinary variations seen in pyæmia, and the sweating in rheumatism is continuous, and not merely the sequence of a rigor. In pyæmia the tongue is usually dry, and perhaps brown, and never presents the creamy-white fur characteristic of rheumatism. The smell of the patient is sweet or "saccharine" in pyæmia, while in rheumatism it is sour, and quite distinctive.

PROGNOSIS.—The prognosis in pyæmia is always bad. The disease is dangerous to life, to health, and to limb. When active acute pyæmia has fairly set in, recovery rarely, if ever, takes place, the patient usually dying between the fourth and the twelfth days. One or two pyæmic rigors may be recovered from. It is the repetition of these attacks, followed by profuse sweating, and attended by extreme exhaustion, that is so fatal. In fact, the danger and the rapidity of the fatal termination in any given case will, *cæteris paribus*, depend on the rapidity of the recurrence of the rigors and their severity.

When the pyæmic attack is from the first subacute or chronic, it may be recovered from, usually after prolonged illness, the formation of numerous or large abscesses, and great and continued disturbance of the general health.

In these less active and acute forms of pyæmia, one joint is liable to special implication, more particularly the knee, and next the elbow. The diseased action lighted up in it may go on to inflammatory disorganisation. Destructive suppuration may be set up in it, and loss or permanent impairment of utility of the limb will be the inevitable result.

PATHOLOGY.—That the blood undergoes important changes in this disease is unquestionable, and there are many reasons for believing with Virchow, to whom we are indebted for much light on this subject, that at least three different conditions may present themselves; which, although probably co-existing in the majority of cases, yet are of independent origin, and may each prove the sole exciting cause of some special symptoms, which, taken altogether, constitute the disease called pyæmia. These three conditions are—

1. An increase in the number of the colorless blood-corpuscles, constituting the affection termed **Leucocytosis**, which has been commonly viewed as a proof of the admixture of pus with the circulating fluid.

2. The formation of **Thrombi**, and the changes which take place in them, leading to **Embolism** or **Metastatic Deposits**.

3. An absorption of ichorous or putrid matter, and the commingling of this with the blood-stream, producing the condition called **Ichorrhæmia** or **Septicæmia**.

It will be desirable to consider these three conditions and their consequences *seriatim*.

1. **Leucocytosis**, or increase of the white corpuscles, with a corresponding increase in the amount of fibrine in the blood, is dependent upon an over-action of the lymphatic glands, arising from an irritation applied to a part freely supplied with lymphatic vessels. The character of the irritation has, however, an important influence in determining the occurrence of this condition; thus, an erysipelatous or diffuse phlegmonous inflammation, affecting at an early period the lymphatic vessels and glands, may be expected to produce leucocytosis far more rapidly and certainly than a superficial inflammation of the skin due to traumatic or other simple causes. In consequence of the adhesive character of these white corpuscles, they may often be found, when present in

considerable numbers, to be collected into masses or groups attached to the walls of the vein, thus giving rise to the belief that they are really pus-corpuscles, from which indeed they are indistinguishable, and that they are the products of inflammatory changes in the walls of the vessels. This may be well seen in any part where coagulation has taken place, the clot presenting a layer of milky whiteness due to the entanglement of the white corpuscles in the meshes of the fibrine. It cannot be doubted that any considerable increase in the numbers of bodies possessing such marked powers of adhesion, both to one another and to the walls of the vessels, must tend to diminish the freedom of the circulation through the smaller vessels and capillaries, and thus facilitate the occurrence of stasis in the vessels. This condition of the blood seems to be connected with a state of general depression, and a pallor or a certain yellowness of the skin. How far it is connected with the formation of the metastatic and secondary abscesses characteristic of the true pyæmic state, is not yet determined; although the demonstration of the passage of the white corpuscles through the walls of the vessels, and their further development into pus-corpuscles, renders the view sufficiently plausible, that some such connection exists.

2. The subject of **Thrombosis** and **Embolism** is one of the most important that can engage the attention of the scientific Surgeon, as upon a full comprehension of the circumstances attending these processes will in great measure depend his knowledge of the pathology of this disease

The *Causes* which lead to the formation of a thrombus or clot in a vessel are of three kinds, viz.—

a. Retardation of the blood-stream; due to (α) Diminished *vis a tergo;* (β) Diminished calibre of the vessel; (γ) Interruption of its continuity.

b. Changes in the condition of the wall of the vessel, or the presence of foreign bodies; due to (α) Imperfect nutrition of the wall of the vessel, complete or incomplete; (β) Injuries to the wall, or presence of foreign bodies.

c. Altered conditions in the blood itself; due to (α) Leucocytosis; (β) Septicæmia.

A thrombus forms more frequently in a vessel of medium size than in one of very large or very small calibre; and, as might be expected, more frequently in a vein than in an artery of equal magnitude. The phenomena attending the formation of a thrombus in an artery have been already considered, and it will therefore only be necessary here to review those results of coagulation in the veins which are intimately connected with the subject before us. It will be desirable to consider the influence of these causes *seriatim.*

a. Diminished *vis a tergo* may result from want of power in the contractions of the heart. This may be due to old age, bad nourishment, cardiac disease, or to severe shock or loss of blood from an injury or operation. The force of the heart is also weakened in all exhausting febrile diseases, as erysipelas, severe traumatic fever, or hospital gangrene. Interruption to the proper distribution of the force through want of elasticity in the arteries acts in the same way. The current of blood under these circumstances flows with less rapidity through the veins, and coagula are liable to form around the valves or in any dilatation that may happen to exist. Another very common cause of retardation consists in the *diminution of calibre* produced by the pressure of a tumor upon a vessel, or by the contraction following inflammatory exudation in the substance of an organ: examples of these conditions may be fre-

quently seen in the iliac veins pressed upon by a pregnant uterus or an ovarian tumor, and in the vessels of a cirrhotic liver; and it must be remembered that a tight bandage may act in exactly the same way. The most important cause, however, is undoubtedly the *interruption of the flow of blood* which follows the division of a vein during a surgical operation. Several circumstances influence this result in an important manner; thus, if a vein be divided immediately below the site of a pair of valves, these being closed by the pressure from above, coagulation will take place in the column of blood thus rendered stationary; the clot may be limited or may extend to a considerable distance along the vessel, and not unfrequently small isolated thrombi form around the valves of the venous trunks leading from such an occluded branch. This process has been commonly described as phlebitis, the coagulation being viewed as secondary to the inflammatory changes in the coats of the vessel, which usually ensue, sooner or later. These considerations offer a probable explanation of the evil effects which frequently follow the application of a ligature to a large venous trunk; because, as a large column of blood is in these cases rendered stagnant, coagulation rapidly sets in and is not easily limited.

b. Amongst the second class of causes, *inflammation of the coats of the vessels*, arteritis and phlebitis, formerly occupied the most prominent position. Hunter described two forms, the suppurative and adhesive; and he considered that an exudation was thrown out upon the surface of the lining membrane, which acted as the exciting cause of the thrombosis. This has, however, been shown to be incorrect. The external coat may become inflamed, and the muscular coat suffers secondarily and becomes swollen, producing not only a narrowing of the calibre of the vessel but some irregularity in its inner surface. This may lead to coagulation; and it is by no means necessary for this that the inflammatory action should reach the stage of suppuration, and that necrosis of the inner coat should take place. All that is necessary is, that the inflammation should be sufficiently severe to deprive the living wall of the vessel for a time at least of its vital properties; and this may occur, as experiment has shown, at a point far short of actual death. It is possible, therefore, for phlebitis to give rise to the formation of a thrombus, and afterwards to pass off, leaving the clot enclosed in a healthy vessel, under which circumstances it may undergo gradual absorption and perhaps partial organisation without doing further mischief. In the great majority of cases of phlebitis it is, however, now believed that the inflammation of the wall of the vein is the result of the thrombus which has arisen from one of the causes here mentioned, and not the primary cause of the coagulation. Coagulation in a vein thus differs from the same occurrence in an artery, for the deposit of fibrine which takes place upon the roughened walls of a degenerated artery must be considered as having a protective influence, and as tending to lessen the danger of rupture. The protrusion of *foreign bodies*, such as spicula of bone, or fragments of atheroma or fibrine, may give rise to the formation of a thrombus at any spot, and may be considered under the same head as embolism.

c. Among *changes in the blood* itself, which lead to the formation of thrombi, those conditions already described under the head of leucocytosis necessarily occupy an important position, as tending not only to diminish the rapidity of the flow in consequence of the increased viscidity of the fluid, but to cause an increase in the amount of coagulable material or fibrine. It is doubtful whether this condition alone would suffice

to produce coagulation in the vessels; it must, however, be a powerful predisposing cause. It is probable, also that certain septic conditions of the blood may tend to increase the liability to coagulation in the smaller vessels and capillaries in consequence of altered or arrested function of certain organs—lungs, liver, or kidneys. This is, however, probably the least important influence produced by septic conditions of the blood, which seem rather to lead to the softening and breaking down of clots than to their formation.

Changes.—A thrombus, having formed, usually undergoes certain changes either of a destructive or a productive character, the results being classed as follows:—

a. Changes in the clot itself leading to organization, obsolescence, or softening and breaking down;

b. Changes in other parts due to the formation of the clot, viz., changes in the walls of the vessel and the establishment of the collateral circulation; or, to the destruction of the clot.

The wall of the vessel usually contracts upon the contained clot, which gradually shrinks, becomes denser, more fibrillated, and ultimately penetrated by vessels. It may subsequently undergo calcareous degeneration, leading to the formation of phleboliths, not unfrequently found in venous plexuses. The changes which end in disintegration produce, however, the most serious results, leading to secondary hæmorrhage in the case of the arteries, and to blood-poisoning or metastatic deposits in that of the veins. The causes which lead to these changes are somewhat obscure; but they are generally dependent upon bad hygienic surroundings and septic or epidemic influences. The healthy organization and absorption of a clot cannot take place if the wall of the vessel enclosing it and the surrounding parts be in a state of inflammation and suppuration; and this state of things is no doubt one of the most frequent causes of disintegration. Diffuse inflammation spreading up the loose connective tissue surrounding the vein not unfrequently leads to a similar result. The general health of the patient has the same influence on the absorption and organization of a clot as it has on the growth of healthy granulations on the surface of a wound. In those conditions in which we find wounds foul and unhealthy, and discharging sanious or ichorous pus, we suspect that thrombi, if present in any vessel of magnitude, will run great risk of disintegration. Those bad hygienic surroundings and septic or epidemic influences which cause one condition, equally produce the other. Whenever a clot is actually exposed to decomposing matter, it of course rapidly decomposes and disintegrates itself. It is remarkable how very rapidly large clots may become disintegrated, and be washed away by the blood-stream in a state of minute subdivision, sometimes without producing any apparent results. Should, however, the fragments be of larger size, the phenomena of **Embolism** are produced; or should they be impregnated with the products of unhealthy inflammation or decomposition, the most grave blood-poisoning is the result; these effects have been carefully studied by Virchow, to whose admirable researches science is indebted for an explanation of the results of these processes.

An **embolon** is a solid body which has entered the current of the circulation. It may consist of detached fragments of fibrine, calcareous or atheromatous matter, foreign bodies, or entozoa. The effects which it produces will depend upon its size and qualities, and upon the position of the circulation into which it may have entered. Thus it may become arrested in vessels of considerable size, or in the smallest arteries or

capillaries; if it commence its career within an arterial trunk, it may become impacted in the smaller branches or in the capillaries of the systemic circulation; whereas, if it arise within a vein, it will probably be arrested in the branches of the pulmonary or the portal circulation. Sometimes, though rarely, the special characters of the embolon will enable the observer to decide as to what may have been its origin and course. It has been doubted whether a fragment of notable specific gravity entering the right side of the heart from the vena cava could be propelled into the branches of the pulmonary artery and thus become impacted in the lung; the experiments of Virchow have, however, indisputably proved the possibility of this occurrence. It is to embolism that modern pathologists ascribe the formation of most, if not all, the metastatic abscesses found in the lungs of patients who have died pyæmic; and they consider that the embolon is derived rather from the destruction of pre-existing thrombi, than from the entrance of true pus into the circulation. Much attention has been directed to the question whether the admixture of pus with the blood necessarily leads to the occlusion of vessels, and the formation of capillary thrombi; and the inquiry can hardly be said to be exhausted. There can, however, be no doubt that, although the granular corpuscles of pus and blood are identical in their microscopic characters, they yet differ materially in their vital properties, and that the presence of pus in any notable quantities would lead to the occlusion of vessels and its consequences. The impaction of an embolon is indicated by the sudden occurrence of certain general symptoms, such as pain, numbness, or rigor; but the special symptoms will necessarily vary according to the organ affected; thus in embolism of the brain paralysis will follow, whilst in that of the lung dyspnœa is most prominent. The immediate local effect of the occlusion of a vessel is the production of intense congestion in the surrounding parts, which is usually followed by hæmorrhage and the consequent production of the hæmorrhagic infarcts commonly seen in these cases; the changes which subsequently take place in the part affected will depend upon the facility with which the collateral circulation is established, and upon this also will depend in great measure the maintenance of its vitality. The appearances produced by these changes will vary with the structure of the particular organ in which they occur, with the character of its vascular supply, and with the exact point at which the body has become impacted. For a full account of these peculiarities, the reader must consult special works on Pathological Anatomy.

It must not, however, be supposed that the occurrence of embolism and pyæmic abscesses stand invariably in the position of cause and effect; it is only under certain conditions, at present imperfectly understood, that the former may give rise to the latter. It is, indeed, a matter of common occurrence to find hæmorrhagic infarcts in the spleen or kidney, or more rarely in the liver or lung, without there being any reason to suppose that the patient had, at the time of their occurrence, suffered from any pyæmic symptoms. It is, in fact, the character of the embolon itself that determines the subsequent results, and there is no reason to believe that a simple embolon, whether arterial or venous, has any tendency to set up acute inflammation changes at the spot where it lodges, merely by its mechanical action. On the other hand, if the embolon be impregnated with the infective products of unhealthy inflammation, or of decomposition, wherever it lodges acute inflammatory changes, culminating in abscess or gangrene, must necessarily result. This has been experimentally proved by Virchow, Cruveilhier, Panum,

Savory, and others, by the introduction of small solid masses into the circulation. It was found that when the foreign body was in itself unirritating, as wax, India-rubber, &c., only the ordinary changes due to the local disturbance of the circulation followed its impaction in the pulmonary vessels; but when it possessed chemical or mechanical irritating properties, inflammation invariably occurred. The effect was most marked when the embolism consisted of animal matter in a state of decomposition. Savory showed that putrid pus, or blood-clot, injected without being previously filtered, always gave rise to pyæmic abscesses in the lung, while the same fluids, carefully filtered, produced no abscesses, but gave rise to intense fever and symptoms of general blood-poisoning. Pyæmic abscesses may, however, occur in an organ having no direct vascular connection with the part in which the original lesion exists, and in circumstances which render it impossible to conceive that any solid particles could have passed from the one to the other; we must, therefore, seek for some other cause to account for their formation, and this will lead us to the subject of blood-poisoning.

3. The third condition which is present in many cases of so-called pyæmia, and which is probably the actual cause of many of the symptoms, is that of blood-poisoning, **Icorrhæmia** or **Septicæmia**, due to the absorption of ichorous or of putrid matter, and its entrance into the circulation. This subject has been investigated experimentally by a very large number of observers during the last ten years, amongst whom we may mention, as the most distinguished, Burdon Sanderson, Billroth, O. Weber, Hueter, Savory, and Davaine. The results of their labors may be summed up as follows. The injection of any fluid into the blood of an animal, even pure distilled water, will give rise to a temporary elevation of temperature. The injection of fluids derived from a part in a state of acute inflammation always raises the temperature considerably, but if the inflammation be of an unhealthy character the effects are much more marked. In the same way, severe effects may be produced by the injection of carefully filtered infusions of organic matter in a state of decomposition. The milder effects produced by these injections consist simply of a brief attack of fever with its usual symptoms, thirst, anorexia, high temperature, and quick pulse, and when these have passed away the animal is as well as before. The more severe effects are of two kinds, acute and chronic. The acute are characterised by rigors, high fever, diarrhœa, vomiting, acute internal inflammations, as peritonitis, pleurisy, or pericarditis, and in some cases by metastatic abscesses and by patches of diffuse cellulitis. In extreme cases, the animal may die collapsed in a few minutes before fever can declare itself. Every stage may be produced at will between these cases of most malignant blood-poisoning and the mildest febrile disturbance, by varying the nature of the fluid and the conditions of the experiment. The chronic effects produced, supposing the animal to escape the acute pyæmic condition, are identical in every way with tuberculosis, consisting of an overgrowth of the lymphatic tissues. The effects produced in these experiments vary, 1st, with the nature of the fluid injected; 2nd, with the quantity injected; 3rd, with the mode of injection; and 4th, with the animal experimented on.

1. *The Nature of the Poison.*—Dr. Burdon Sanderson has shown that the fluids capable of producing the most potent effects are in all cases characterized by the presence of minute organisms variously spoken of as bacteria, microzymes, or micrococci, and that the effect produced varies to a certain extent with the appearance of these organisms. The

part which they play in the process of infection is at present undetermined. That they can appear in the products of subcutaneous inflammation which have never been exposed to the external air is certain, but this is no proof of their having been generated at the part, as they may have come from without and found their way to the inflamed spot by the blood. There is no evidence to show that the poison need be of any specific character, like that of an acute specific disease. It has been abundantly proved by experiment that all the symptoms of septicæmia or blood-poisoning may be produced by the injection of simple albuminous matter in a state of decomposition. On the other hand, it is not necessary that the fluid injected should be in a state of decomposition or putridity; in fact, the most maglignant effects are produced by fluids free from decomposition, and their effects diminish in intensity as the fluid decomposes. Thus, to take a single example, Dr. Sanderson injected some solution of ammonia, which had been previously boiled and cooled, into the peritoneum of a guinea-pig. The fluid resulting from the acute peritonitis so produced was injected into the peritoneal cavity of a second guinea-pig, and so on from one guinea-pig to another for a series of five, and lastly some of the fluid from the last guinea-pig into a dog. The time the first animal survived was about twenty-four hours; but in each succeeding injection the time became shorter, till at last the potency of the fluid had so far increased that a dog only survived its injection seven hours, thus showing "that it is possible to proceed from an inflammation of purely non-infective origin, to the artificial induction of a process of the most intense virulence." The exudation-fluids in these experiments were found to be full of microccoci, and their potency was diminished by putrefaction. This curious increase in the virulence of the poison as the result of transference from one individual to another is, to say the least, very suggestive to the practical Surgeon, and should make him doubly careful, lest by the use of sponges or by his own unwashed hands he shouid, as it were, repeat the experiment on his patients.

2. The intensity of the effect varies with *the quantity* injected, when the injections are made directly into the blood If the injections of the more virulent fluids be made under the skin or into a serous cavity, they excite local inflammations, the fluid product of which possess the same virulent properties, and thus the effect will not vary so directly with the amount of fluid injected.

3. *The Mode of Injection.*—Some fluids, for the reason just stated, act more powerfully when injected into a serous cavity or into the subcutaneous cellular tissue than when injected directly into the blood.

4. *The Animal Experimented on.*—Dr. Sanderson has clearly shown that different classes of animals are differently affected by the same poison, and that different individuals of the same class present very different powers of resistance. Thus all rodents are peculiarly susceptible to infective processes, while dogs are much less so. Sanderson thinks that the human subject is probably intermediate between the two. That different individuals of the same species are differently affected by the same poison, is a point of great interest. It is doubtless the same with the human subject, and in all probability the susceptibility to the effects of these virulent infective poisons varies greatly from time to time in the same individual. This we have unfortunately only too often the opportunity of verifying by the observation of dissection wounds. A student in robust health may usually inoculate himself with impunity from almost any dissection or *post-mortem* examination, but one ex-

hausted with over-work or dissipation would under the same circumstances run the greatest risk of blood-poisoning. In the same way, there can be no doubt that the patients admitted into a hospital from dirty homes and from every condition of bad hygiene, are far more liable to suffer from blood-poisoning than those who have lived in better circumstances.

By what channel the poison enters the system is still uncertain; it may be either by the veins or by the lymphatics. Of one thing, however, there seems to be no doubt, that healthy granulations under circumstances of ordinary pressure offer a decided barrier to the passage of any of these infective materials into the blood, and it is also just as certain that recent wounds, before their surfaces are covered with organising lymph or granulations, offer them a ready entrance. In fact, the experiment of injection of decomposing matter into the lymphatics is often unintentionally performed by the Surgeon. If a wound of any size under ordinary dressing be closed too tightly, and no drainage be provided for the necessary serous discharge, it will be found that after about 36 to 48 hours the patient's temperature rises perhaps to 103° Fahr. or 104° Fahr., and all the signs of severe fever set in. On looking at the wound the stitches will be found to be tight, on removing one the serous fluid will flow out, having a distinct odor of decomposition, and the fever will then gradually subside. Here the decomposing fluid will have been pent up at high pressure in a cavity surrounded on all sides by the unclosed lymphatics, which have been divided in the wound, and the experiment of injection is as accurately performed as if done with a syringe under the skin of a dog. It merely requires that the quantity of fluid injected should be sufficient, or that the susceptibility of the individual should be great enough, to convert such a case as the above into one of septicæmia. In the same way, there is reason to believe that the fluid portions of pus pent up at any degree of pressure in the cavity may be absorbed. If the pus be healthy, the effect will be merely to produce the ordinary febrile disturbance accompanying such conditions, but if unhealthy or decomposing, it may give rise to intense blood-poisoning. There is no reason to believe that the entrance of pus corpuscles into the blood plays any part in the process—as originally supposed by Arnott, Hunter, Bérard, and Sédillot. It will be seen, therefore, from what has been said above, that in the opinion of many modern pathologists no sharp line can be drawn between ordinary surgical or traumatic fever and septicæmia—just as Sanderson has shown that no sharp line can be drawn between inflammations, the products of which possess decided infective properties, and those which do not; and no one at present can say exactly where one ends and the other begins.

Briefly then, to sum up our present knowledge of pyæmia it may be stated that,

1. The metastatic abscesses can in many cases be distinctly traced to the results of embolism; the embola having started from softening clots in the veins of the part from which the disease originated, and being impregnated with some poison which causes them to excite acute inflammation wherever they lodge. This poison may be in some cases something specific, of which we have no knowledge at present, or it may consist of the products of ordinary decomposition.

2. The other symptoms of pyæmia are fully accounted for by the entrance of the same poisons into the system in a fluid or minutely subdivided form.

3. The most characteristic feature of the fluids which possess these

infective properties is the presence of minute organisms, bacteria, microzymes, or micrococci; but whence these originate, or what part they take in the process of infection, is still a disputed point.

4. Cases occur in which embolism forms no part of the affection, and others in which embolism is all important and blood-poisoning comparatively secondary. The former are included by some Surgeons under the names of septicæmia and ichorrhæmia, and the latter under the names of pyæmia or embolæmia. In this country, however, it is more common to extend the name pyæmia to both conditions.

Post-mortem Appearances.—After the above brief sketch of the more important pathological conditions which constitute the pyæmic state, the appearances to be found after death in any fatal case may be described.

The body usually changes rapidly after death, decomposition setting in at an early period; the skin is generally of a dirty yellow tinge, sometines intensely jaundiced, with numerous spots of livid mottling, due to the occurrence of local congestion. Any external wound may present a grey, sloughy, or dry appearance; and dark red lines may be seen extending upwards, indicating the course of the veins or lymphatics.

The **Blood** will often be found to be of a dark color, fluid, or imperfectly coagulated, although sometimes it may present no abnormal appearance whatever. Large numbers of white blood-corpuscles may be readily seen under the microscope, sometimes collected into masses, or entangled in a clot so as to give it a milky-white appearance. The red corpuscles are frequently found to have broken up even before death, and the serum to be consequently darkly stained with blood-pigment.

The **Heart** is frequently the seat of small extravasations, which may be found either beneath the pericardial or endocardial lining, or in the muscular substance itself. Sometimes, though not very often, abscesses are found situated either in the wall or in the papillary muscles; these are usually small collections of puriform matter, rarely much larger than a pea, and often surrounded by a zone of congestion or hæmorrhage. The muscular substance is flabby, and the lining membrane of both the heart and aorta is more or less deeply stained by imbibition of the coloring matter of the blood. Pericarditis may result primarily from the formation of metastatic abscesses in the heart, but is usually secondary to the inflammation of the pleura, which is often very intense Occasionally diffuse acute inflammation of the muscular structure of the heart is found, without any distinct abscess having been formed.

The **Lungs** are much congested, especially at the posterior bases, where the tissue is friable; sometimes this congestion passes into true pneumonia, which almost always exists to some extent at least. The most important condition present in these cases is the existence of *metastatic absces es*, which may vary much in number and size. These are commonly found scattered over the surface, and are almost invariably surrounded by a zone of condensed lung-tissue, the result either of inflammatory action or of hæmorrhagic injection; and are still further surrounded by an area of active congestion. The position of these abscesses is usually indicated on the surface by a slight elevation; their form is most commonly wedge-shaped, the broader part or base being directed towards the surface. The central part of the mass consists of a grey slough, which may or may not have softened down into a grumous semi-fluid matter. The area of hæmorrhage, measuring from one-eighth to half an inch in breadth, may present the ordinary characters of lung-apoplexy, closely resembling damson-cheese on section; or, it

may appear of a tawny-yellow color from partial reabsorption of blood-pigment. The size of these deposits varies greatly, from less than that of a pea to two or three inches in diameter. They are most commonly found on the posterior surface of the lower lobe, or in the interlobular fissure. The pleurisy which accompanies, and probably in most cases results from, the formation of the deposit is often very severe. The pleural surface is freely covered with patches of inflammatory lymph, whilst corresponding quantities of deeply covered turbid fluid are usually collected into the pleural sac. Sometimes, though rarely, small collections of pus are found scattered through the substance of the organ without affecting its pleural surface, or giving rise to any of the wedge-shaped masses above described.

The **Liver** frequently presents no abnormal appearances, even in severe cases, where the lungs have suffered most markedly; in others, again, it is the seat of many abscesses, which often attain a very large size. They have much the same character, both as to form and position, as those in the lungs, and are usually surrounded by a zone of hæmorrhage and congestion. When, however, they occur as primary abscesses without any deposits in the lungs preceding them, they may appear as simple collections of pus, having a more or less branched arrangement. This form of pyæmic deposit does not appear to be the result of embolism, but to be referable to those other conditions of ichorrhæmia or septicæmia which have been already described. It must be remembered that hepatic abscess may result from intestinal mischief, either typhoid or dysenteric; and therefore the occurrence of this condition does not necessarily indicate the existence of general pyæmia. In cases in which the general blood-poisoning is more marked than the local effects, the liver is found to be swollen, its structure is soft and more friable than usual, and its color uniform and muddy. The epithelium is found on microscopic examination to be excessively granular.

The **Spleen** is usually large, soft, very friable, and often of an almost pulpy consistence. Infarcts unconnected with the pyæmic state are frequently met with in this organ; metastatic abscesses are not, however, very common.

The **Kidneys** probably stand next to the liver in the order of frequency with which they are affected. They are almost invariably swollen and soft; the epithelium cloudy, excessively granular, and often choking the tubules in irregular masses. They are very frequently congested, and sometimes the seat of destructive nephritis; when abscesses appear, they present the same varieties as those found in other parts.

The **Intestines** rarely suffer, but abscesses may be found in the submucous or subserous areolar tissue. Local peritonitis not unfrequently follows the formation of hepatic abscesses, and may become very severe. Of the other organs, the **prostate** is the most commonly affected; abscesses forming in the venous plexuses which surround this body. Metastatic deposits rarely form in the **brain**, although embolism of the cerebral arteries is not uncommon as a result of valvular disease of the heart.

One or more **Joints** are usually found to be swollen and tender; and on opening them a large quantity of pale yellow or thick, flaky, and puriform fluid escapes. There are congestion of the synovial fringes, and softening or destruction of the cartilage.

The general character of the anatomical lesions present in this disease may be summed up as follows:—a general tendency to local congestion, inflammation or extravasation of blood, accompanied by the formation of slough or abscess, due in the majority of cases to thrombosis or em-

bolism, but in other cases to changes in the blood itself, which almost always presents remarkable fluidity and a tendency to rapid decomposition. In other cases, with the exception of the local abscesses, the appearances may be those of a perfectly healthy body.

Treatment.—The **Preventive Treatment** of pyæmia consists in a scrupulous attention to those hygienic measures which have been described in the earlier chapters of this work; and, above all, to a careful avoidance of *overcrowding.* It is impossible to speak too forcibly on the necessity of avoiding this evil in surgical wards, if we wish to prevent outbreaks of pyæmia. The more the patients are isolated, the less will be the liability to pyæmia. If the aggregation of patients favors the development of this disease, their segregation is the best preventive: abundant cubic space of air, free ventilation, and scrupulous attention to cleanliness will do more to prevent the development and spread of pyæmia than any other precautions that may be adopted. In fact, none are of any avail if these be neglected. Yet it is impossible not to admit that the constitution of the patient himself may have much to do with the production of the disease; and it is often distressing to the Surgeon to feel that, whatever care may be bestowed upon the patient after an operation or accident, in these respects, the evil influences to which he has been exposed previously to its occurrence may have so contaminated his blood, that pyæmia becomes almost an inevitable sequence of any suppurative inflammation that is set up

As it is now well known that the absorption of decomposing animal fluids is an efficient cause of all the symptoms of pyæmia, too great care cannot be taken to prevent putrefaction in the discharges. Lister states that by his antiseptic method of treating he has almost abolished pyæmia in his practice. As, however, from what has been said before while treating of the pathology of pyæmia, it is clear that the disease may arise independently of decomposition, no system of dressing can be expected absolutely to prevent it in all cases. A few exceptional cases will probably occur, in spite of everything that can be done to prevent it.

In addition to ordinary prophylactic hygienic measures, there are a few of a more special character. Thus, pus should always be freely let out, especially if it be sanious, decomposing, or offensive. Quinine or iron may be given before an operation, or as soon after as the patient's condition will bear it; and a liberal supply of good nourishment enjoined. Disinfectants, especially carbolic acid and the chlorides, should be freely used. Some Surgeons have advocated the internal administration of agents that have a special antiseptic character, as the hyposulphites and sulpho-carbolates; but their use does not seem to have been attended with the benefit that was expected from them on theoretical grounds.

The **Curative Treatment** of pyæmia is most unsatisfactory. It doubtless happens that patients occasionally recover from this disease, even after the formation of diffuse abscesses; but such a result must be looked upon as a happy exception to its commonly fatal termination. The only plan of treatment that holds out any reasonable hope of success, appears to me to be the stimulating and tonic one, consisting of brandy or wine, ammonia, bark, and beef-tea; in fact, that plan of treatment which is usually adopted in low fevers and inflammations. I have certainly seen service done in some cases, and indeed recovery effected, by the administration of large doses of quinine; five grains being given every third or fourth hour, with the best effect. Beyond this I do not think it necessary to go. Among many others I may mention a very

serious case of pyæmia following amputation of the arm, and accompanied not only by all the symptoms of that disease in a very marked degree, but by pleuritic effusion, swelling and tenderness over one hip, and secondary hæmorrhage from the stump, which was cured under the tonic and stimulating plan of treatment. The quinine very decidedly checks the rigors; but does not appear to influence the temperature or the sweats. In some cases I have administered the chlorate of potash largely (ʒij to ʒiv in the day), in addition to the quinine and wine, with apparent benefit. If the depression be very great, carbonate of ammonia in five to ten or even fifteen grain doses may be given, well diluted, from time to time; such fluid nourishment as the patient will take, with a liberal allowance of wine, porter, or brandy, being administered. In addition to this medicinal treatment, hygienic measures must be put in force. The patient should throughout be placed in an airy and well-ventilated apartment, and cleanliness carefully attended to.

In the case of a superficial vein being inflamed, it has been recommended by Bonnet, Bérard, and Laugier, that the actual cautery should be fully applied along the course of the vessel; and they state that the best results have followed this practice. As abscesses form, they must be freely opened: and the diffuse and purulent collections forming in the areolar tissue must be evacuated; the cavities being well syringed out with antiseptic lotions. In cases arising as the consequence of acute osteo-myelitis following amputations or compound fractures, removal of the limb at the next joint above the affected bone has been recommended and successfully practised by Sir J. Fayrer, even after one or more well marked rigors.

If convalescence take place, the patient will slowly recover. The rigors and sweats will gradually become less frequent; the appetite will improve; the countenance will lose its anxious expression, and the skin its unhealthy hue. But strength returns slowly. The disease may assume a relapsing character. Great caution, therefore, is necessary before a patient can be pronounced safe. Even after recovery he will continue pale and wasted; energy is lost; nutrition is impaired; and at a more remote period some low form of disease, as phthisis or albuminuria, may prove fatal.

CHAPTER XXXIV.

TUMORS.[1]

The frequency with which *Tumors* fall under the observation of the Surgeon, the great variety in their characters, and their important rela-

[1] The most exhaustive treatise on this subject is Virchow's great work, "Die Krankhaften Geschwülste" (the Pathology of Tumors), whilst in his "Cellular Pathology" will be found an exposition of his views of the development of new formations. The reader will find in Paget's classical "Lectures on Surgical Pathology" the best account in the English language of the clinical characters of these growths. He may also consult with advantage Rindfleisch's "Histological Pathology" (translated for the New Sydenham Society by Dr. Baxter), Billroth's "Surgical Pathology" (American Edition), and the "Manual d'Histologie pathologique," by Cornil and Ranvier, vol. i. I am under much obligation to my friend, Mr. Goodlee, for his kindness in having undertaken the illustration of this chapter with a series of drawings taken from nature, which are alike admirable for their fidelity and their artistic merit.

tions, local as well as constitutional, render their consideration one of great moment. According to Hunter, a tumor is "a circumscribed substance produced by disease, and different in its nature and consistence from the surrounding parts." This definition, though not perhaps accurately correct in some forms of tumor, which do not differ in their nature from neighboring parts, is yet clinically convenient. By a tumor may also be meant a more or less circumscribed mass, growing in some tissue or organ of the body, and dependent on a morbid excess of, or deviation from, the nutrition of the part. These growths may therefore be considered under the two heads of local hypertrophies, or outgrowths of the normal structure of the part; and of new formations, presenting structural characters which differ more or less widely from those of the parts around. The tumor thus formed increases in size by an inherent force of its own, irrespectively of the growth of the rest of the system, but still obeys the same laws of growth which govern the body generally. In order to constitute a tumor, it is necessary that the normal form of the part be widely departed from; a mere increase in its size, so long as it preserves its usual shape, being scarcely considered in this light. Thus if the tibia be uniformly enlarged to double its natural size, the enlargement is a hypertrophy; but if a comparatively small rounded mass of bone project directly forwards from its tuberosity, it is said to be a tumor and not a mere hypertrophy.

Classification of Tumors.—A classification of tumors may be founded either upon their anatomical structure, or upon their vital and clinical characters; and although these two systems may occasionally lead to a somewhat similar grouping of individual growths, yet our knowledge is at present too imperfect to enable us to point out in every case the connection between clinical history and histological structure. Surgeons have long divided tumors into two great classes—the **Non-malignant** and the **Malignant**. This division, however, though practically convenient, is not scientifically exact. Although some tumors, as the cancers, are always and essentially malignant, and others as uniformly benign, as lipomata and some cysts, yet many others that are usually innocent may, under certain conditions at present unknown, take on a truly malignant action: this has led to the establishment of an intermediate group that may be termed the **Semi-Malignant**.

The **Non-Malignant, Innocent,** or **Benign Tumors** are strictly local in their development, and are rarely connected with any constitutional or hereditary peculiarity. They resemble more or less completely the normal textures of the part in which they grow, and hence are very commonly, though not perhaps with strict propriety, termed *homomorphous* They usually, though not invariably, grow slowly, are more or less distinctly circumscribed, being often enclosed in a cyst or loose capsule of connective tissue, and have no tendency to involve neighboring structures in their own growth; any change that they induce in contiguous parts not consisting in the degeneration or conversion of these into their own structures, but simply in displacement or atrophy by their size and pressure. They are usually single, but not unfrequently multiple, developing either simultaneously or successively; but if in the latter mode, without any connection with preceding growths. If removed by operation, they do not return; but if left to the ordinary processes of nature, they slowly attain a great size, remain stationary, and, at last atrophy, decay, or necrose.

The essentially **Malignant Tumors** differ widely from those just described. They cannot be considered as strictly local diseases, as in

many cases they result primarily from a constitutional or hereditary vice, or, if local in the first instance, have a tendency rapidly to affect the constitution, and to reproduce themselves in distant parts of the body. They are usually characterised by extreme vegetative luxuriance, but by a somewhat low vitality, being prone to early decay; the peripheral parts being usually in a state of active growth, while the central are undergoing fatty degeneration, ulceration, or gangrene. They represent an extreme departure from the ordinary nutrition of the part; and, when once found in an organ or tissue, they develope by an inherent force of their own, irrespectively of neighboring parts, producing masses which differ entirely in structure and appearance from anything observed in the normal condition of the body, and hence are not unfrequently called *heteromorphous*. This term, however, cannot be considered strictly accurate; inasmuch as the microscopic elements of which the masses are composed have their several analogues in the normal structures of the body. But though the individual constituents of the tumor may be normal, their aggregation and mode of arrangement are totally abnormal, and differ from everything met with in a healthy state of the tissues. The mass, which may either be infiltrated in the tissues, or localised, increases quickly in size; not uncommonly, indeed, the rapidity of the growth may be taken as a measure of the malignancy of the tumor. As it increases in size, it tends to implicate the neighboring structures in its own growth, and to affect distant organs through the medium of the lymphatics or the blood; if removed by operation it has a great tendency, under certain conditions, local and constitutional, to return in its original site or elsewhere, though it does not necessarily do so. If left to its own development, a malignant tumor will inevitably soften, necrose, and ulcerate, often with much pain, profuse hæmorrhage, and the induction of a peculiar state of constitutional cachexy, which speedily and necessarily terminates in death.

The following may be looked upon as the principal *signs of malignancy* in those tumors—as cancers, which are clinically as well as anatomically malignant—in which, in fact, the structure taken as a whole differs from anything that normally exists in the body, and in which the progress of the disease has an invariable tendency to proceed from a primary local to a secondary constitutional condition.

1. The tumor, whether arising spontaneously or as the result of external violence, whether occurring in an individual in whom there has previously existed an hereditary tendency to similar or to allied disease, or in one whose progenitors have never evinced any tendency to similar affections, is invariably at first small, and is usually defined, with a distinct outline.

2. There is a constant tendency to the extension of the disease by local infiltration into and the absorption of neighboring structures; not only by their mere absorption by the pressure of an increasing growth, but by their actual incorporation into its very substance, and the deposit of the morbid mass in their place.

3. This process continues uninterruptedly; in many cases very slowly, as in scirrhus of the breast; in others, in special forms of disease and in certain situations, as in encephaloid of the testes, very rapidly.

4. The rapidity of the growth of the tumor, and of the absorption and incorporation of the neighboring structures, is usually in the measure of and in proportion to the malignancy of the affection.

5. There is no limit to the size of the growth; but when it reaches a certain point of development, its central parts undergo fatty degenera-

tion, and in some cases a sort of cicatricial contraction. When it reaches the surface, it speedily sloughs or ulcerates towards its centre, giving rise to profuse discharge usually offensive in character, and not unfrequently to abundant hæmorrhage. Even during this stage, its circumference continues to grow and to invade the surrounding parts.

6. At a certain period of the growth—early in some cases, not until many months have elapsed in others—the lymphatic glands immediately above the primary disease, those intervening between it and the central portions of the system, become enlarged and hardened, in consequence of the deposit within them of morbid material identical in character with that which constitutes the primary or original disease. This secondary implication of the lymphatic glands is undoubtedly due to direct absorption. It may occur before the skin is involved; but almost invariably manifests itself when once the integumental structures are implicated in the malignant disease. The disease has a tendency to run the same course in the glands that are thus secondarily affected as it does in its primary seat.

7. At a later period than this the internal organs, more especially the lungs and liver, become the seat of secondary deposits of a similar nature essentially, though differently in some minor characters, to those which were primarily developed in the original seat of its local affection. These secondary visceral deposits occasionally become the foci of new developments of the disease, which assume a more active and fatal character than the primary affection to which they owe their origin.

8. After the contamination of the lymphatic glands, the constitution of the patient exhibits evidences of serious modifications in nutrition and sanguification. The body wastes, the skin becomes sallow, the digestive powers become impaired, and anæmia supervenes.

9. Death may occur in various ways:—from the exhaustive effects of the discharges, and hæmorrhages from the local and primary disease; from special visceral disturbances induced by the secondary deposits; or from malnutrition and consequent cachexy.

The malignant tumors are usually of a cancerous nature, but "*malignant*" and "*cancerous*" are not synonymous terms. Every malignant tumor is not a cancer, though every cancer is a malignant growth. Some tumors occasionally present the clinical characters of malignancy, though structurally they are intimately related to others which are usually looked upon as essentially non-malignant; and we are thus obliged to consider, that these terms are merely relative, and that these two great classes pass into one another by insensible gradations. It will be subsequently seen that the sarcomata and some cartilaginous tumors stand in this intermediate position between the more typical examples of these two great groups. Those benign tumors which have a tendency to recur after removal, and thus to run as it were a locally malignant course, are usually very rapid in their growth and development. Indeed, great rapidity of growth may usually be looked upon as evidence either of malignancy of structure, or of liability to speedy recurrence after extirpation. In some cases, after repeated removals, the tendency to recurrence appears to wear out, and the patient eventually overcomes the disease. But in other instances this fortunate result does not occur. Where tumors of any kind recur after removal, it will often be found that the secondary differs in many important respects from the primary growth. Thus it may be found to be softer, more vascular, and more diffused. In microscopical structure, it may be found to present evidences

of greater activity of growth, and to depart more widely from the normal type.

Paget has very fully described varieties of tumors, which, though differing widely from cancers in structure, have nevertheless destroyed the patient by repeated recurrence after removal, and by ultimate ulceration, sloughing, and contamination of neighboring tissues, or even of distant organs through the medium of the circulation. These tumors he describes chiefly under the names, "fibro-plastic and fibrous" but they are now included under the varieties of sarcoma. He also makes the important observation that tumors, apparently similar in structure, may run very different courses in different individuals, in some being in every way innocent, and in others malignant. Thus a tumor, composed purely of spindle-shaped cells, may in one case show a tendency to recur after removal, or to affect distant parts; whilst in another it may not only infiltrate surrounding tissues, but give rise to secondary growths in internal organs. More extended observation has, however, shown one very interesting difference between the mode of recurrence of these tumors, and that of true cancers. A true cancer of carcinoma invariably affects the lymphatic glands before the internal organs; whilst it is a very frequent occurrence for a sarcoma to become widely disseminated through the body without the lymphatics showing any signs of implication. It would seem, therefore, that, as a rule, carcinoma is disseminated by means of the lymphatic vessels, and sarcoma by the blood-vessels. This rule is by no means absolute, but it is sufficiently constant to form a very interesting feature in the natural history of these diseases. Paget makes the very interesting practical remark, which agrees entirely with the result of my observation, that the children of cancerous parents may be the subjects of tumors not carcinomatous in structure, but closely resembling such growths in the rapidity of their progress, their liability to ulcerate and to bleed, and their great disposition to return after removal.

The term **Semi-malignant** may be employed to include those growths which occupy the doubtful position indicated above : it must, however, be distinctly understood that this term cannot be employed in any very definite sense.

Innocent and malignant tumors are occasionally met with in the same person, four or five different kinds of growth even occurring in one individual. I have seen in one patient a scirrhous breast, enchondromatous tumor of the leg, and an atheromatous cyst on the back, with scrofulous glands in the neck. New formations of different types may even be found in the same mass; thus, encephaloid cancer and spindle-celled sarcoma are said to have been found together in the testes. This, however, must not be taken as any evidence of the possibility of the conversion of one into the other, but rather as the result of a departure in different directions from the normal nutrition. There is indeed no proof that a non-malignant can be converted in any circumstances into a malignant tumor of a different type; a fibrous growth may degenerate and assume many of the characters of malignancy, at last destroying the patient, but there is no evidence that it can ever be changed into a cancerous mass. A malignant tumor may, however, appear on the site of a non-malignant growth that has been removed : thus I have seen a scirrhous nodule deposited in the cicatrix left after the removal of a cystic sarcoma of the breast.

Besides these various forms of tumors, others are met with, of a constitutional and specific character, such as those that occur in connection

with scrofula and syphilis; but these are usually looked upon in this country rather as modifications of chronic inflammation than as tumors.

A classification founded upon an anatomical basis not only enables the observer to comprehend the precise relation which any particular growth under observation bears to others that resemble it; but it leads him to trace the origin of the new formation from the pre-existing structures of the part in which it occurs, thus forming the first step towards a knowledge of the etiology of the disease. Tumors are said to be heterologous or homologous, according as they present a greater or less deviation from the normal condition of the tissues from which they spring. These terms are essentially relative; and it is only to instances at the extreme ends of the series that either term can be definitely applied. The more heterologous the growth, that is, the greater the departure from the normal nutrition of the part in which it occurs, the more malignant, as a rule, will be its action upon the system generally; whilst the reverse, with some exceptions, is true of homologous formations. At the same time it must be borne in mind, that Virchow's law holds good even in the most heterologous departures from the standard of health; this law states, that "the same types of anatomical structures exist in new formations as are found in the body generally," and thereby denies the possibility of the occurrence of a true heteroplasia, and the existence of specific elements in new formations.

The following classification may be adopted as possessing clinical convenience, and, at the same time, presenting, as far as possible, an anatomical uniformity.

I. Cystic Tumors generally.

II. Tumors composed of one of the modifications of fully developed Connective Tissue.

- *a.* Fat—Lipoma.
- *b.* Fibrous Tissue—Fibroma.
- *c.* Cartilage—Chondroma, Enchondroma.
- *d.* Bone—Osteoma, Exostosis.
- *e.* Mucous Tissue of Umbilical Cord or Vitreous Humor—Myxoma.

III. Tumors which resemble in structure more or less perfectly one of the more Complex Tissues of the body.

- *a.* Muscle—Myoma.
- *b.* Nerve—True Neuroma.
- *c.* Blood-vessels. Angioma, Nævus.
- *d.* Lymphatic Vessels—Lymphangioma.
- *e.* Lymphatic Glands—Lymphadenoma.
- *f.* Papillæ of Skin or Mucous Membrane—Papilloma.
- *g.* Secreting Glands—Adenoma.

IV. Tumors composed of Tissue which is either purely Embryonic, or is showing some signs of a tendency to develope into adult tissue of the Connective type.

Sarcomata.—These are chiefly subdivided according to the shape and size of the cells of which they are composed; thus, round-celled, oval-celled, spindle-celled, giant-celled sarcoma, &c.

V. Tumors composed of Cells of an Epithelial Type, arranged in spaces in a stroma consisting of more or less perfectly developed fibrous tissue.

Carcinomata or true Cancers.—Scirrhous, Encephaloid, and Adenoid Cancer, Epithelioma.

General Characters of Typical Tissues.—Before proceeding to consider the individual growths, which are thus grouped together, it

will be desirable to describe briefly the essential features presented by the structures upon which the types of some of the classes are founded.

First as to the **connective tissue**:—This exists throughout the body, presenting, however, many varieties of form adapted to the special functions of each particular part in which it appears. It consists essentially of an intercellular substance, hyaline or fibrillated, in which are embedded cells having an oval, caudate, fusiform, or branched form, and usually presenting a distinct nucleus and nucleolus. In addition to these, in fibrous or areolar tissue, wandering cells, with amœboid movements, are normally present. These are looked upon as identical with the white corpuscles of the blood, and the fixed branched connective-tissue-corpuscles are usually looked upon as derivatives from them. The fixed connective-tissue-corpuscle was looked upon by Virchow and his followers as the starting point from which are derived the various cell-structures, which constitute a large proportion of the products of abnormal nutrition. This view is, however, now abandoned by many and much limited by all pathologists; the wandering white corpuscles from the blood being considered by many to be the only source of new cellular growth, while others believe that although the new growth arises chiefly from this source, yet the pre-existing cellular elements of the part are not wholly inactive.

The following tissues may be considered as belonging to this type, the pathological deviations from which must be viewed in the same light:—the connective or areolar, the white fibrous, and the yellow elastic tissues in all parts of the body, whether entering into the formation of organs, or existing as separate structures. The cartilaginous and osseous tissues represent two important modifications, but exhibit occasionally a tendency to return to the primary form as described above. Mucous tissue must also be included under the same type. Its most perfect analogue is found in the Whartonian jelly of the umbilical cord, but it is also represented in the adult by the vitreous humor of the eye.

The simplest form of **embryonic tissue** is composed of small round cells about the size of white blood-corpuscles, and possessing the same amœboid movements, connected with each other by a small quantity of homogeneous intercellular substance. The cell consists merely of a small mass of protoplasm with a nucleus in the centre, which is usually somewhat difficult to distinguish. The vessels in such tissue are abundant, and extremely thin-walled, like those of granulations. The modifications observable in this tissue are seen both in the cells and in the intercellular substance. The cells may be of great size, almost resembling epithelial cells; they may be spindle-shaped, oval, or stellate. The intercellular substance may be small in quantity and amorphous, or its quantity may be increased without apparent change in its nature. The most common modification is a development of fibrous tissue between the cells. It must be remembered, however, that, in tumors classified under the heading sarcomata, with very rare exceptions the intercellular substance, be it homogeneous or fibrous, extends between the individual cells, in this differing from the stroma in carcinomata, which forms alveolar spaces in which the cells are grouped. In fact, it is one of the essential characters of the epithelial type of tissues, that it presents a simple cell-structure without any intercellular substance. The cells of epithelium present a very great variety in their form and size, and though usually possessing but one nucleus, may sometimes contain several nuclei, as in the transitional epithelium from the bladder.

It is at the present time a disputed question whether cells of an epi-

thelial type can never develope except in connection with pre-existing epithelium, after the first separation of three layers of the embryo. If it be true that they cannot, then primary carcinoma can only arise in connection with the skin, mucous membranes, and secreting glands. The flat cells lining the blood-vessels, lymphatics, and serous cavities are not now looked upon as epithelium, but are distinguished by the name of endothelium or epithelioid cells. They are different in character and origin from epithelium, and can undoubtedly be developed in any part of the body.

The characters presented by the several groups of tumors will now be considered.

I.—CYSTIC TUMORS.

Cystic Tumors may be classified according to their contents, or according to their anatomical characters and mode of development. The following is an example of the former method.

1. **Dermoid Cysts**, presenting three varieties—
   a. Those containing Epidermis.
   b. Those containing True Skin, Hair, and Glands.
   c. Those containing Cartilage, Bone, and Teeth.
2. **Serous Cysts**, arising in four different ways—
   a. By Dilatation of Sacs, Cavities, or Canals, including Blood-Vessels.
   b. By Accumulation of Fluid in the Meshes of Areolar Tissue.
   c. By Changes in Hæmorrhagic Effusions.
   d. By Changes in the Products of Inflammation.
3. **Colloid Cysts**, resulting from—
   a. Colloid Degeneration of Pre-existing Cells.
   b. Colloid Degeneration of Newly formed Cells.

The second method will, however, be adopted here as being the more simple and more clinically useful. Cystic tumors are divided into two great classes:—

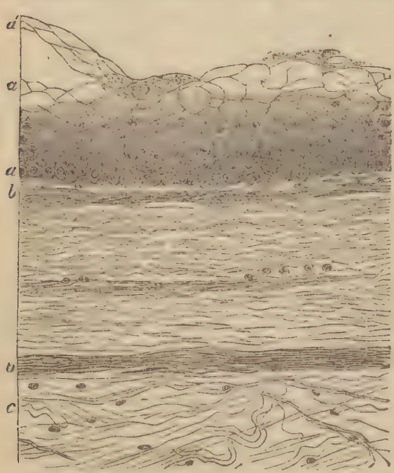


Fig. 270.—Wall of Atheromatous Cyst (188 diam.).
aa. Epithelial lining, the superficial cells swollen and fatty.
á. A flake of fatty cells peeling off.
bb. Fibrous capsule.
c. Surrounding connective tissue.

1. Those that are dependent upon the gradual Accumulation of a Secretion in a naturally existing Duct or Cyst, with dilatation and hypertrophy of its walls.

2. Those that result from the New Formation of a closed Cyst in the areolar tissue of the part, and the distension of it by the secretion from its lining membrane.

1. Encysted Tumors, arising from Simple Distension and Gradual Hypertrophy of the Walls of a Duct or Cyst, are met with in three forms: (*a*) Encysted tumors of the skin and subjacent areolar tissue occurring in various parts of the body, and dependent on

the closure of the excretory ducts of the sebaceous glands: (*b*) Tumors formed by the accumulation of secretions in, and the closure and dilatation of, the ducts of other secreting glands and organs, as in the sublingual or the mammary gland: (*c*) Those formed by the retention and modification of the secretions in cysts without excretory ducts, as in the bursæ.

When these tumors arise in connection with ducts or cavities naturally lined with epithelium, they also possess a similar lining, but if they spring from closed sacs such as bursæ, which are lined merely with a flattened endothelium, we find no true epithelium in the cyst.

(*a*) **Encysted Tumors, produced by the Obstruction of the Excretory Ducts of the Sebaceous Glands,** include the various forms of **Atheromatous Tumors** that are met with on the surface of the body. These are usually situated upon the scalp, face, neck, or back: sometimes, however, they occur elsewhere—thus I have removed a very large one from the fore part of a girl's arm, and others from the labia and groin. The size of these tumors varies from that of a pin's head to an orange; the smallest occur on the eyelids, the largest on the shoulders and scalp. They are often very numerous, especially about the head, where as many as thirty or forty may be met with at the same time; and most frequently they form in women about the middle period of life: they are smooth, round, or oval, movable under the integument, either semi-fluctuating or elastic, though sometimes solid to the touch. In some parts where the sebaceous follicles are large, as on the back, a small black point can often be detected on the surface of the tumor, through which an aperture may be found leading into its interior, and allowing the expulsion of its contents. A sebaceous tumor consists of a cyst-wall and contents. The cyst-wall is composed of dense white fibrous tissue, having elongated connective-tissue-corpuscles scattered through it. It is connected to the surrounding parts by loose areolar tissue, containing yellow elastic fibres in some abundance. The thickness of the wall varies greatly. When the cyst is situated on the hairy scalp, it will always to be found to be tough and thick, while in all other situations it is much thinner. Immediately in contact with the inner surface of the cyst-wall, a layer of actively growing epithelial cells is found closely resembling the deeper layers of the epidermis; further from the wall these assume a distinctly squamous form; then they become filled with fat granules, and finally break down into a fatty, granular mass. The atheromatous mass forming the contents of the cyst is composed of this fatty debris (Fig. 271). If examined when freshly removed from a tumor, it will be found to be soft creamy pultaceous, or sometimes cheesy-looking, of a yellowish white color. Sometimes in old cysts it becomes dry and laminated, looking not unlike Parmesan cheese. In some cysts of old standing and large

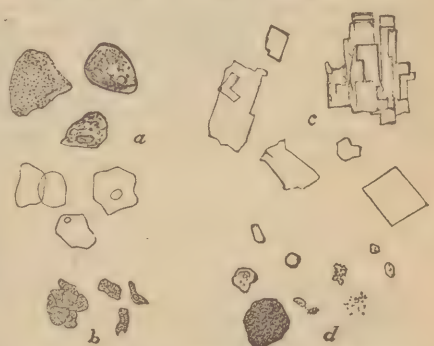


Fig. 271.—Contents of Atheromatous Cyst (454 diam.).
a. Epithelial cells undergoing various degrees of fatty degeneration.
b. The same with calcareous degeneration.
c. Crystals of cholesterine.
d. Oleaginous and fatty particles.

size, the contents may be semi-fluid, the more liquid parts being a brown, green, or blackish tint. These various contents are essentially composed of sebaceous matter, mixed in various proportions with epithelial scales, fat-granules, and cholesterine. Sometimes the cyst-wall is found to send fibrous septa towards the centre of the cyst, but true papillæ or hair follicles are never found in cysts due to obstruction of the excretory ducts of a sebaceous follicle. Occasionally a part of the cyst-wall may undergo calcification, and calcareous particles may be found among its contents (Fig. 271, b). Some forms of cysts of new formation closely resemble those just described in their contents and naked-eye appearances, but differ from them in the structure of their walls, which is that of true skin. These will be referred to again under "dermoid cysts."

Progress.—The growth of these tumors is often very slow; but not unfrequently, after remaining stationary for years, they increase rather rapidly. The tumor itself, though painless, may give rise to uneasy sensations, by compressing nerves in its vicinity; it usually continues to grow slowly, until the patient, being annoyed by its presence, has it removed by operation. If left untouched, it occasionally, though rarely, happens that the sebaceous matter, exuding through an aperture on its surface, forms a kind of scab or crust, which by a process of sub-deposition becomes conical; and, being gradually pushed up from below, at the same time that it assumes by exposure a dark brown color, forms an excrescence that looks like a horn, and is usually considered to be of that character. These "horns" have been met with on the head, on the buttock, and in other situations. The accompanying drawing (Fig. 272), is taken from a child four years old, brought to me to have its horn removed; a woman also once applied to me with one about an inch and a half long, growing from the upper lip.

Fig. 272.—Horn on Nose of a Child.

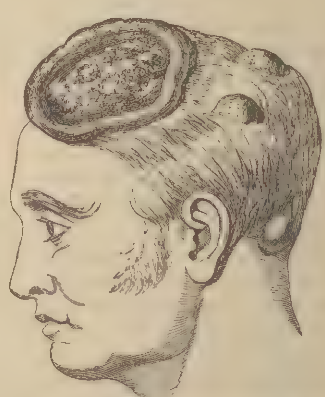


Fig. 273.—Ulcerated Encysted Tumor of Scalp.

In other cases, these tumors inflame and suppurate; the skin covering them becomes adherent and reddened, ulceration takes place, and, if the cyst be small and dense, it may be thrown off by the suppurative action in the surrounding tissues. If it be larger, ulceration of the integuments covering it takes place, and the sebaceous matter is exposed; this may then putrefy, become offensive, and break away in unhealthy suppuration. In other cases, peculiar changes take place in this tissue: large granulations are thrown out in it, and the cyst-wall appears to vascularise, becoming irregular and nodulated, rising up in tuberous growths with

everted edges, exuding a fetid, foul discharge, becoming adherent to subjacent parts, and assuming a semi-malignant appearance, forming at last a sore as large as a saucer (Fig. 273), and then closely resembling epithelioma. Sebaceous cysts which have undergone this change may, however, readily be distinguished from malignant growths by a microscopical examination of their exudations or *débris;* these consisting of pus and healthy epithelium, mixed up with fatty matters more or less disintegrated.

Diagnosis.—The only diseases with which these tumors can be confounded are abscesses and fatty growths. From an *abscess* an encysted sebaceous tumor may be distinguished by its history, slow growths, situation, elasticity, and mobility, and the existence of the dilated orifice of the sebaceous duct, through which some of the contents can be squeezed, the microscopical examination of which will serve to confirm the diagnosis. From *fatty tumors* these growths may be diagnosed by their firmer and more regular feel: and in case of doubt, by the evacuation and examination of their contents. Sometimes the cysts may be lobulated so as closely to resemble a fatty tumor (Fig. 274). But even

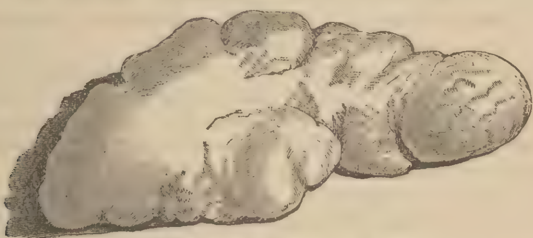


Fig. 274.—Large Atheromatous Cyst from the Back, simulating Fatty Tumor. (Half the natural size.)

in these cases they may be distinguished by the Surgeon pressing on the edge of the tumor; if cystic it will remain fixed, and the finger can be pressed through it; if a lipoma it will roll away.

The *Treatment* of a tumor of this kind simply consists in its removal, after which it is never reproduced, unless a small portion of the cyst-wall have been left behind. So long as these tumors are small, and do not give rise to deformity or inconvenience, they may be left without surgical interference. But when large, and more particularly when they have become inflamed, they should be removed. The method of operation will vary according to their situation and the thickness of their walls. When situated on the scalp, where the cyst is dense and tough, the tumor may very readily be removed by transfixing the upper part of it and the skin covering it with a scalpel, squeezing out the atheroma, and then seizing the edge or bottom of the cyst-wall with forceps and pulling it out. In this little operation there are two points that require attention; first, the base of the cyst should never be transfixed; and, secondly, no attempt at dissection should be made: if either of these precautions be neglected, troublesome hæmorrhage may ensue. No dressing is required after the operation, beyond a piece of dry cotton-wool laid on the wound, which will generally heal by the first intention. Should it not do so, water-dressing should be applied. When these tumors occur upon the scalp, a large number may be removed at one sitting; as, however, there is always some danger of erysipelas following operations in this situation, it is only prudent to select a favorable season of the year, and not to operate if the health be out of order. Erysipelas is the only danger

to be apprehended: it is especially apt to occur in elderly people of a stout make and florid complexion. When seated about the back, trunk, or limbs, they usually require to be dissected out, being thin and more closely incorporated with the skin; and often, in consequence of former inflammation, adherent to the subjacent parts. In doing this, care should be taken that the whole of the cyst-wall is extirpated; the wound, which should be dressed lightly, speedily heals. If, however, any portion of the wall be left, it should be freely rubbed with nitrate of silver, lest a troublesome fistula remain. When the tumors are situated between the shoulders or on the back, and the patient is unwilling to submit to an operation, I have sometimes easily and successfully removed them by opening up with a probe the small black orifice, which will always be found leading into them, squeezing out the contents of the cyst, and then pushing in two or three silk threads, which, acting like a seton, have excited the requisite amount of inflammatory action to bring about a closure of the cyst.

In some cases, in which, from the constitutional condition of the patient, or from prejudice on his part, the use of the knife is objectionable, these cysts may be removed by rubbing the surface freely either with potassa fusa or fuming nitric acid. When the slough so formed separates, the cyst comes away with it.

The horns and semi-malignant ulcers that result from these growths, may require excision. If, however, the ulceration be connected with the cranium by its base, or be very extensive, as in the case depicted (Fig. 273), it will be safer to treat it by the application of chloride of zinc, or by occasionally touching it with fused potass.

(*b*) Various forms of encysted tumor may arise from the **Closure and Dilatation of the Ducts of other Excretory Organs**, as, for instance, cystic tumors of the breast from the obstruction of the lacteal ducts, ranula from obstruction of the duct of the submaxillary gland, mucous cysts of the mouth or vagina from the obstruction of the ducts of the mucous glands. These affections, however, constitute special diseases, the consideration of which must be deferred to subsequent chapters. The general principle of *Treatment* of such diseases consists either in restoring the freedom of the outlet by the excision of a portion of the wall, or obliterating the cyst by making an incision into it, and allowing it to granulate from the bottom.

(*c*) **Cysts may arise from Distension of Cavities which are unprovided with any Excretory Duct**, as, for instance, the bursæ, which often attain a very considerable size in these circumstances. Cystic tumors formed in connection with the sheaths of tendons, or *ganglia*, belong also to this class; and strictly speaking, hydrocele of the tunica vaginalis testis should also be included. When arising from bursæ, the normal structure of the wall of the bursa becomes greatly altered; sometimes it is thin and expanded; at others it acquires a thick fibrous, almost ligamentous appearance. Inside, the cyst is often warty-looking, and its walls are often laminated, the layers being composed of imperfectly developed fibrous tissue. Sometimes by gradual thickening of the cyst-wall the central cavity becomes almost obliterated, and the disease assumes the form of a solid tumor. Not infrequently attached to the walls, and floating in the interior, are a number of granular melon-seed-like bodies, greyish or yellow in color, semi-transparent, elongated or irregular in shape, usually rather hard, but sometimes soft and flocculent. The fluid contents of these cysts are usually thin and serous, of a yellowish or brownish color. In their progress they are found to

increase up to a certain size, when they usually thicken and harden, in consequence of the fibrous transformation just described; or else they inflame and suppurate in an unhealthy manner. They may occur in any of the situations in which bursæ naturally exist or are accidentally formed, but are most commonly met with upon the knee-cap, the nates, or the first-joint of the great toe, where they give rise to the affection known as *bunion*.

The simple forms of cystic tumors of the ovary may be placed under this head, as they arise from dilatation of the Graafian vesicles, and are filled with a more or less clear serous fluid. They sometimes attain an enormous magnitude.

The *Treatment* of the cysts derived from bursæ consists in attempting their absorption by the use of stimulating plasters; or, if this fail, in the removal of their contents by tapping. The cavities are then closed by exciting inflammation and suppuration within them, by the introduction of a seton, by injection with stimulating solutions, or by the subcutaneous section. If these means fail, excision will be required, more especially if the tumor have become dense and fibrous.

2. **Cysts that result from the New Formation of a Closed Cyst, and the Distension of it by the Secretion from its Lining Membrane.**

Under this heading must be included (*a*) Dermoid Cysts; (*b*) Serous or Simple Cysts; (*c*) Compound Proliferous or Multilocular Cysts; (*d*) Sanguineous Cyst or Hæmatoma.

(*a*) **Dermoid Cysts.**—These were described by Lebert as presenting three chief varieties. 1. Cysts closely resembling in structure the ordinary atheromatous cyst before described, only occurring in situations in which sebaceous follicles are not normally found. These are rare. 2. Cysts whose walls present all the structures of true skin; cuticle, papillæ,

Fig. 275.—Wall of Dermoid cyst from the Arm (49 diam.).
a. Epidermis.
b. Hair follicles.
c. Sebaceous gland.
d. Surrounding connective tissue with small masses of fat.

cutis vera, sweat-glands, sebaceous follicles, hair follicles, and hair. (Fig. 275.) Their contents are usually rather thinner than those of the ordinary atheromatous cyst, though closely resembling them in appearance. Often a small ball of coiled-up hair is found inside the cavity.

The contents are the accumulated secretions of the glands in the cyst-wall mixed with desquamated epithelium. These cysts are by no means uncommon. They are always congenital, although they may perhaps not be noticed for some little time after birth. One of the most common situations in which they are found is at the outer angle of the orbit; here they are excessively thin-walled, requiring very careful dissection for their removal. If a small piece of the cyst-wall be left behind, it will give rise to a troublesome fistulous opening, or even the cyst may re-form itself. Occasionally the bones of the skull have been found to be absorbed or not developed beneath these tumors, a fact which it is important to remember in attempting their removal. These cysts have also been found beneath the skull. 3. The third variety of dermoid cysts includes those peculiar tumors which contain teeth and portions of bone. These have been supposed to be the remains of blighted ova inclosed in the body, but this view is by no means proved. These tumors are most frequently met with in the abdomen, especially about the ovaries, mesentery, and omentum; they have also been observed in connection with the testis, having probably descended into the scrotum with this gland. A very remarkable case of this kind once occurred at University College Hospital, under Marshall. They have also been found in the lung, but never, I believe, in connection with the extremities.

Cysts containing fatty matters present several varieties. The contents may be derived from the fatty degeneration of epithelial structures, or of the contents of a cyst originating in any of the ways above described. Sometimes the fatty matters are in the form of a half-fluid oily emulsion, or of a white cheesy mass of the consistence of soft putty; at others they present a very peculiar appearance known as *Cholesteatoma* (*Perlgeschwulst*, *Tumeur Perlée*). This consists of a smooth, laminated, white and dry fatty mass, contained in a cyst, and composed partly of concentrically arranged epithelial cells, and partly of crystalline fat and cholesterine. Virchow has described this as a distinct variety of tumor, and considers that it is not necessarily connected with epithelial formation. It usually occurs in the temporal bone, but has been found in the cerebellum. It is a very rare form of tumor.

(*b*) **Serous or Simple Cysts** are met with in almost every situation, being composed of a thin expanded wall containing a slightly viscid serous fluid. They are usually found to be lined with a flat endothelium, like that lining the serous cavities. One of their most frequent situations is in the neck.

The *Compound*, or as they are often called, *Proliferous* or *Multilocular Cysts*, are especially met with in the ovary, and have been studied with great care by Hodgkin, and more recently by Wilson Fox. Of these there are two varieties, the first consisting of an aggregation of simple cysts closely packed and pressed together; the second composed of cysts having others growing from their walls. The cavities of these multilocular cysts present the greatest possible variety in their contents; fluid, from a limpid serum to a semi-solid jelly-like matter, and of every shade, from light-yellow to greenish-black or dark brown, is met with in them: solid intracystic growths, cancerous masses, or the *débris* of epithelial and cutaneous structures, are also found in them.

Wilson Fox has shown that these secondary cysts are the results of constrictions of portions of the ducts of glandular structures, associated with the hypertrophy and fresh growths of tubular formations; a view which satisfactorily explains the occurrence of epithelium and other adenoid structures within them. Some of the secondary cysts associated

with the papillary growths appear to result from the cohesion of adjoining masses of papillary structure, and thus present cavities lined with epithelium, similar to that which lines the parent cyst and the papillary mass itself. The intracystic growths themselves appear to be derived from the superficial strata of the stroma of the cyst-wall; and, as they arise by protrusion into the cavity of the cyst, they are necessarily covered by the same epithelium which lines the latter.

Villous growths are also found scattered in patches on the inner surface of the cyst-wall. They are always highly vascular, consisting almost entirely of loops of vessels covered by a layer of epithelium. These are intimately connected with the development of gland-structures.

The term *Proliferous* is also applied to those cysts in which solid intracystic growths are found, as in the proliferous cyst of the mamma. The growths projecting into these cysts assume a lobulated or cauliflower-like form, and in structure are found rudely to resemble the normal structure of the mamma. These "intracystic" growths may cause by their increase in size the gradual absorption of the more fluid contents until, at last, their development is arrested by the cyst-wall. The tumor would then merely resemble an ordinary adenoma of the mamma surrounded by a distinct capsule.

The *Sanguineous Cyst*, or *Hæmatoma*, is a peculiar variety of the simple form, and has been described by Paget as principally occurring about the neck, the parotid, the anterior part of the thigh, the leg, the shoulder, and the pubes. It is especially characterised by containing fluid blood, more or less altered in appearance. He describes these cysts as being formed in three possible ways; either by hæmorrhage into a previously existing serous cyst, by transformation from a nævus, or by a vein becoming occluded and dilating into a cyst. I have seen a large hæmatoma on each ear of a lunatic. The contents were semi-solid coagulum. These sanguineous cysts may sometimes resemble in general appearance encephaloid disease. A case of this kind was sent to me by Henry Bennet—a tumor of about the size of an orange, of nodulated appearance, existing in the leg of a woman below the knee, where it had been gradually increasing in size for about a couple of years. So close was the resemblance to malignant disease presented by the tumor, that the limb had been condemned for amputation by some Surgeons who had previously seen the case; as, however, the growth, on examination, proved to be a sanguineous cyst, as its walls were thin and adherent, and as it extended too deeply into the ham to admit of ready removal, I reduced it by successive tappings, and then, laying it open, allowed it to granulate from the bottom. When practicable, however, the cyst should always be dissected out.

In several cases recently reported, it has been found that the so-called blood-cyst, or hæmatoma, was in reality a sarcoma, the structure of which had been broken down by hæmorahage. See "Sarcomatous Blood-cysts."

The term *Hæmatoma* or *Blood-cysts* is also applied to those cysts that result from changes taking place in extravasated blood (see p. 202). The most perfect cysts resulting from this cause are found in the arachnoid cavity. The coagulated blood in the course of time becomes completely discolored, and forms a thin membrane-like layer of tissue which encloses a cavity containing a small quantity of serous fluid. There are excellent specimens of this condition in University College Museum.

Cysts of new formation occur frequently *in connection with various solid tumors*, and are then due to softening, or hæmorrhage, or to dila-

tation of cavities existing in the structure of the tumor. Thus in enchondromata, large cysts are frequently found as the result of mucous softening of the matrix of the cartilage; in myeloid sarcomata cysts are very common, probably due to hæmorrhage into the structure of the tumor; and in adenoid tumors of the breast, the imperfect acini characteristic of the growth may become dilated into cysts. These cysts will be described more fully with the various tumors in which they occur.

Cysts also occasionally come under the care of the Surgeon which owe their origin to the presence of a *parasite*. The most common of these is that known as the hydatid cyst. This is due to the presence of the scolex (or young) of the tænia echinococcus. The parasite in this stage of development is cystic in form. It never reaches its fully developed state in the human body; the tænia (or tape-worm), of which it is the scolex, being only known to exist in the dog and wolf. In the human body it is commonly found to present the following appearances. Most externally is a cyst-wall composed of the tissues of the part, altered by the pressure of the cyst, and indurated by fibroid growth. Within this is the wall of the cyst belonging to the parasite. This is often half an inch or more in thickness, and is composed of a semi-transparent, elastic substance, not unlike the white of a hard boiled plover's egg. It is beautifully laminated to the naked eye, and a still finer lamination is seen under the microscope This cyst is spoken of as the *acephalocyst*. Sometimes the cyst is single, but frequently numerous secondary or daughter cysts are found in its interior. The contents of the cyst consist of a clear fluid of very low specific gravity, usually not over 1007°, and containing either no albumen, or only the faintest possible trace. The characteristic tænia-heads, or, as they are called, echinococci, are found either adherent to the cyst-wall, or free in the fluid. The head is small and rounded, and about $\frac{1}{100}$ in. in diameter, and provided with four suckers and a ring of hooklets. Frequently no perfect echinococci can be found, but the hooklets, being indestructible, can usually be detected. Hydatid cysts are found in almost any part of the body. They occur most frequently in the liver, and in other organs in the following order of frequency:—lungs, muscles and subcutaneous tissue, kidneys, lower pelvis, nervous centres, bones, and heart. They are in rare cases found in the eye. The cyst-wall may undergo calcification, and the tumor cease to trouble the patient. Occasionally suppuration may occur round the cyst, and the whole may be discharged. A few years ago I opened a very large abscess in the adductor region of a young woman's thigh, and gave exit to nearly a pint of pus, in which dozens of small hydatid cysts about the size of gooseberries were floating. The diagnosis of these cysts when seated in the subcutaneous or muscular tissues cannot be made with certainty, except by withdrawing some of the fluid with the aspirator, and submitting it to microscopic and chemical examination. If it be of low specific gravity and free from albumen, it is almost certain to have come from a true hydatid cyst. The *Treatment* of these cysts, when practicable, is the complete removal of the parasite. In internal organs, tapping, aspiration, and simple acupuncture, have all been successful. A few years ago I successfully removed a hydatid cyst of the size of a fist from the muscles at the back of the neck of a young man.

II.—TUMORS COMPOSED OF ONE OF THE MODIFICATIONS OF FULLY DEVELOPED CONNECTIVE TISSUE.

The structures included under the term connective tissue and its modifications are fat, fibrous and areolar tissue, cartilage, bone and mucous tissue. The tumors composed of any of these tissues in a state of perfect development are almost uniformly benignant. Occasionally enchondroma assumes a malignant form, but it will then be usually found that, instead of being covered by a firm fibrous membrane at the margin of the growth, there is a zone of embryonic tissue which is infiltrating the surrounding parts on one side and becoming developed into cartilage on the other. It is from this tissue, probably, that the system becomes infected, and not from the fully developed cartilage. In the same way, tumors which to the naked eye seem to be composed of bone may assume all the characters of malignancy; but on microscopic examination it will be found that these tumors do not grow as normal bone does, either from a fibrous membrane (periosteum) or from cartilage, but are in fact ossifying sarcomata. These will be described amongst the sarcomata. Again, there is no absolute boundary between sarcoma and fibroma. Many tumors composed almost entirely of spindle-cells contain a large proportion of fibrous tissue between the cells. If the fibres very much exceed the cells, the growth would be called a fibroma; if the reverse a sarcoma; and one between the two is often spoken of as a fibro-sarcoma. As a broad rule, it may be said that the benignancy of the growth will be in proportion to the perfection of the development of the tissue of which it is composed.

a. **Fatty Tumor or Lipoma.**—These tumors constitute an important class of surgical diseases, as they occur very extensively in almost every part of the body, and at all ages, though they are most commonly met with about the earlier periods of middle life. In the majority of cases they appear to originate without any evident cause; in other instances they can be distinctly traced to pressure or to some local irritation, as to that of braces or shoulder-straps over the back and shoulders. In one case I have known the disease to be hereditarily transmitted to the members of three generations of a family.

Fatty accumulations take place under two forms, one diffused, the other circumscribed; it is the latter variety only that is termed the **Adipose or Fatty Tumor**. The diffused form of fatty deposition occurs in masses about the chin or nates without constituting a disease, though it may occasion much disfigurement. This form was described by Brodie under the name of "fatty outgrowth."

Fatty or adipose tumors may form in all parts of the body as soft, indolent, inelastic, doughy swellings, sometimes giving rise on manipulation to a feeling closely resembling fluctuation. They grow very slowly, and are usually oval or round in form, but frequently lobulated to a most extraordinary degree. They occur most frequently in the subcutaneous fat about the neck and shoulders, and are occasionally met with between or even in muscles, in the neighborhood of joints and of serous membranes and of mucous canals, sometimes in very unusual situations, where such growths would scarcely be looked for. Thus I removed some time since a lipoma three inches in length, and as thick as the thumb, from under the annular ligament and the palmer fascia of a young woman. A very curious circumstance connected with these tumors is that they occasionally shift their seat, slowly gliding for some distance from the original spot on which they grew; thus, Paget relates

cases in which fatty tumors shifted their position from the groin to the perinæum or the thigh. I have known one to descend from the shoulder to the breast. When growing superficially, they sometimes become pedunculated. They may attain a large size, but only occasion inconvenience by their pressure or bulk; sometimes they appear in great numbers, upwards of 250 tumors of various sizes having been found in the same individual. They rarely ulcerate or inflame, nor do they undergo any ulterior changes of structure.

The typical **lipoma** is simply a mass of fat, usually differing in structure in no way from the ordinary subcutaneous adipose tissue (Fig. 276), but it is not uncommon to find crystalline deposits of the fatty acids in the cells. It is inclosed in a fine thin capsule having small vessels ramifying over its surface. This capsule is adherent to the surrounding structures, but loosely connected with the tumor itself, so that, in operating for the removal of these growths, it is important thoroughly to open the capsule before attempting to remove the tumor.

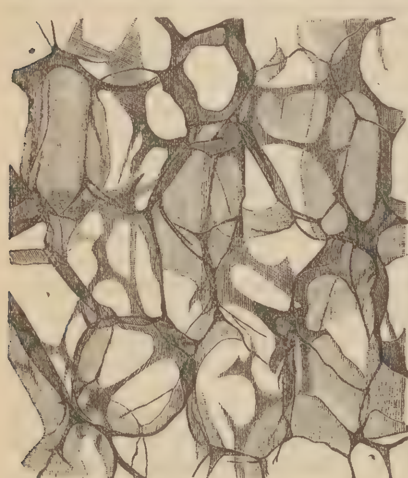


Fig. 276.—Fatty Tumor (188 diam.). Some of the cells show crystals of fatty acids.

These tumors, which present the least possible deviation from the normal structure of the parts in which they grow, are derived from the connective tissue by an increased development of fat. They present occasionally some minor varieties of structure. Thus the fibrous tissue may be in excess, giving rise to the so-called "fibrous lipoma," or the tumor may be permeated by numerous dilated vessels, as in the "erectile lipoma." These conditions are, however, rare; occasionally mucous tissue may be found intermixed with the adipose, forming the "myxo-lipoma." This will be again mentioned under myxoma.

In the *Treatment* of fatty tumors little can be done except by extirpation with the knife, by which the patient is speedily and effectually rid of the disease. The tumor, being encapsuled and but loosely adherent to adjacent parts, readily turns out if the capsule be freely opened. Great care must be taken that none of the lobules frequently found in these tumors are left behind, as they would certainly serve as starting points for new growths. The wound often heals by first intention. It is true that we have the sanction of Sir B. Brodie's high authority for the administration of the liquor potassæ in some cases, under which treatment this eminent Surgeon states that fatty tumors have occasionally disappeared.

b. **Fibroma; Fibrous or Fibroid Tumors, Desmoid Tumors, areolar and Fibro-cellular Tumors.**—In the healthy body, fibrous tissue is found either dense and firm as in tendons, or loose and filamentous as in areolar tissue, and between these two extremes every variety of density is observed. In healthy areolar tissue two kinds of fibres are almost invariably present: the white fibrous and the yellow elastic tissue.

In tumors composed of fibrous tissue, similar variations in density are found. Thus we have fibrous tumors as dense in structure as ligaments, and others as loose as areolar tissue, but in all it is extremely uncommon to find any yellow elastic fibres. Fibrous tissue enters very largely into the composition of many tumors besides the true fibromata. Thus the stroma of most cancers is composed of fibrous tissue, the intercellular substance of a sarcoma may be abundantly fibrous, and in a lipoma the lobules of fat are bound together by areolar tissue. The term fibroma is, however, only applied to those tumors in which fibrous or areolar tissue forms by far the most abundant constituent, and in which the cells are not of an epithelial type and are not arranged in definite groups. As before stated, no sharp line can be drawn between fibroma and sarcoma, and the term fibro-sarcoma is frequently applied to those tumors in the border-land between the two. Fibromata may be divided into two chief classes:—1. Soft fibromata, areolar tumors, and fibro-cellular tumors; 2. Firm fibromata, desmoid tumors, and fibroid tumors.

1. **Soft Fibromata.**—These may be diffused or circumscribed and encapsuled. The diffused variety or *areolar tumors* are little more than a simple hyperplasia of the subcutaneous or submucous areolar tissue. They are represented by pendulous fleshy growths, forming large tumors, commonly called **Wens**, which may occur on any part of the surface. They are smooth, peduculated, firm, somewhat doughy, but non-elastic, pendulous, and movable, slowly increasing without pain often to a very great size. They are thinly covered with skin, bearing abundant papillæ, and sometimes enlarged sweat-glands and hair-follicles. Large vessels may ramify on the surface, and occasionally the skin is pigmented. They are sometimes congenital. In the disease known as molluscum fibrosum these tumors form pedunculated masses of rolls, hanging from the skin of the buttocks, thighs, and other parts of the body, and may attain such a size as seriously to inconvenience the patient by their weight. These masses are composed merely of connective tissue, sometimes dry and tough, and sometimes œdematous. They contain large blood-vessels, frequently of such size as to render removal of the growth a most hazardous operation. A somewhat similar condition is seen in the disease known as **Elephantiasis Arabum**, in which the skin and areolar tissue of the affected part undergoes an enormous hypertrophy; but the new growth in this case is not pedunculated, and is moreover distinctly connected with repeated attacks of inflammation of the lymphatic vessels of the part. It is in warm climates and in the Hindoo and negro races that this disease attains its greatest development. It chiefly attacks the genitals, the hypertrophy affecting the skin and areolar tissue of the scrotum and penis in the male, forming an enormous mass fifty, seventy, or even a hundred pounds in weight, or depending from the labia in the female. The remarkable enlargement of the leg occurring in the Mauritius and some parts of the West Indies, and hence termed Barbadoes leg, is an affection of this kind. The skin in these cases becomes dark colored, rough and scaly, like that of an elephant, whence the name of the disease. It should perhaps be classed rather with diseases of the lymphatic system than with tumors properly so called.

In the *Treatment* of these affections, pressure and iodine applications may be tried in the earlier stages, with the view, if possible, of checking their growth; at a later period they must, if large, be removed by operation, though this procedure is at times an extremely severe one, owing to the great size.

Tumors of the *circumscribed variety*, described by Paget as fibro-cellular, are not of common occurrence; and when met with they are most frequently found in the scrotum, the labium, the deep muscular interspaces of the thigh or axilla, and on the scalp, in which situation they may form large masses, attaining sometimes to a weight of many pounds. When seated in the subcutaneous tissue these tumors may become pedunculated, as in the accompanying figure (277), which represents a tumor of this kind which I removed from the side of a woman. I have removed one weighing nearly four pounds from the axilla of a woman, where it lay between the serratus magnus and the ribs, forming a tumor of great size. When they occur about the scrotum and labium, these tumors must not be confounded with elephantiasis of these parts, from which they may be distinguished by being limited and circumscribed masses, and not mere outgrowths. Paget observes that, when occurring about the genital organs, they are found in young women and in old men. They happen only in adults who otherwise are in good health, and grow quickly, forming soft, elastic, rounded, and smooth tumors: they are not attended by any pain. After removal they are found to possess a thin capsule, to be of a yellowish color, and to contain a large quantity of infiltrated serous fluid, which may be squeezed out abundantly, and coagulates on standing. This fluid may be so abundant as to give rise to distinct fluctuation. Thus, a few years ago, I removed a soft fibroma from amongst the short muscles of the thumb, which had been previously treated unsuccessfully by puncture, under the impression that it was cystic in nature.

Fig. 277.—Pendulous Fibro-cellular Tumor.

Under the microscope these tumors display a beautifully delicate network of white fibrous tissue, arranged in undulating filaments and fibrous bands, in the midst of which stellate, spindle-shaped, oval or round cells are found. These cells are similar to those normally found in fully developed or growing fibrous tissue. They vary in abundance, but never exceed the fibrous tissue in amount. The cells are rendered more apparent by the addition of acetic acid. These tumors sometimes appear to grow rapidly, when, in reality, the increase in size is due to a rapid increase of the fluid, and not to a new deposit of a solid character in the tumor. As these tumors are perfectly innocent, no hesitation need be entertained about their removal.

2. **Firm Fibromata—Fibroid or Desmoid Tumors.** — These tumors are met with in various situations, the most common of which are the bones and periosteum, the mamma, the subcutaneous connective tissue, and in connection with nerves. In the uterus "fibroid" tumors are exceedingly common, but in this situation they contain not only fibrous tissue, but also a variable amount of non-striated muscular fibre. Amongst the best known examples of firm fibromata may be enumerated, the simple or fibrous epulis, the fibrous tumors of the antrum of lower jaw, the fibrous polypus of the nose, the ordinary or false neuroma, and the painful subcutaneous tubercle. Fibrous tumors are also seen in the

neck, especially in the parotid region. In shape these tumors are irregularly oval or rounded; they are smooth, painless, and except when growing from bone they are freely movable; they grow slowly, but may attain an enormous size, equal to that of a cocoa-nut or water-melon. Liston removed one from the neck, which is at present in the Museum in the College of Surgeons, that weighed twelve pounds; they have, however, been found weighing as much as seventy pounds. They are almost invariably single; they are excessively firm and hard, but yield slightly on pressure, in this differing from bony tumors. When cut into, they present a white glistening fibrous structure, often showing, to the naked eye, bundles of interlacing fibres. Sometimes the fibres show a concentric arrangement (Fig. 279); an appearance which, according to Bill-

Figs. 278, 279.—Firm fibromata (188 diam.). Figure 279, from a small Fibroma of the forehead, shows the circular arrangement of the fibres. Figure to the left, from a naso-pharyngeal polypus, resembles ordinary fibrous tissue.

roth, is due to the fibrous formation taking place around nerves and vessels. On microscopic examination, pure fibromata are found to be composed of interlacing bundles of white fibrous tissue, scattered amongst which are cells, few in number, and spindle-shaped, stellate, or oval in form (Fig. 278). These are often only rendered apparent by the addition of acetic acid. In most cases the vessels are not abundant, but frequently these tumors can be shown by injection to be very vascular. Sometimes coarse cavernous spaces may be found. The vessels are intimately adherent to the fibrous structure of the tumor, and consequently being unable to contract or retract, they pour out enormous quantities of blood if opened by wound or ulceration. This is especially the case in those fibrous tumors which grow from the bones of the head or face, as in the fibrous polypi growing from the body of the sphenoid bone. Hæmorrhage is moreover often a marked symptom of fibroid tumors of the uterus.

Fibromata form most commonly about middle life, and may remain stationary for years, and this is the condition in which they are often presented to the Surgeon. They may, however, suffer various anatomical changes. They may undergo disintegration, becoming œdematous, and softening in the centre, or at various points of the circumference; they then break down into a semi-fluid mass, the integuments covering them inflame and slough, and unhealthy pus, mixed with disorganised portions of the

tumor, is poured out, leaving a large and sloughy chasm, from which fungating growths may spout, readily bleeding on the slightest touch, and giving the sore a malignant appearance; the patient eventually falling into a cachectic condition, and becoming exhausted by the hæmorrhage and discharge. In other cases these tumors may calcify, or more rarely undergo true ossification. In rare cases the central parts of these tumors may undergo a process of softening, so as to form large cysts containing fluids of various shades of color. Paget relates the case of a very large cyst of this kind formed by the hollowing out of a fibroid tumor of the uterus, which was tapped by mistake for ovarian dropsy.

Some of the forms of fibroma require further mention here, though they will be again mentioned under the diseases of the organs in which they occur.

Fibromata of Bone.—These may grow from the centre of the bone, as is not unfrequently seen in the lower jaw, or from beneath the periosteum. The diagnosis between these latter and the firmer varieties of sarcoma can only be made after removal. Virchow lays great stress upon the fact that periosteal fibromata do not penetrate into the structure of the bone, or show any tendency to infiltrate the surrounding soft parts, while the reverse is the case with the sarcomata.

Fibromata of Nerves.—These are commonly spoken of as neuromata, although this term would be more properly limited to those tumors in which newly formed nevre-filaments are found. They form rounded tumors, over which the fibres of the nerve are stretched; they are frequently multiple, sometimes extremely numerous, very hard and dense, and almost invariably painless, and not affecting the function of the nerve upon which they grow. They are always more movable in a direction transverse to the course of the nerve upon which they are seated than in any other; a symptom which is of some importance in their diagnosis.

Fibromata of Glands are rare, being almost confined to the mammæ.

Painful Subcutaneous Tubercle is a peculiar form of fibroma, found beneath the skin, usually of one of the extremities, and very rarely of the trunk. It is seldom more than half an inch in diameter, and is so small as scarcely to cause a prominence on the surface, yet it gives rise to pain of the most intense and agonizing character, usually called forth by some slight touch or pressure, and then lasting perhaps for an hour or more. These tumors are not neuromata; at any rate, no connection has as yet been traced between them and nerve-filaments. They are by far more frequent in females than in males.

Fibroid Tumor of the Uterus.—These tumors, as before stated, are not pure fibromata. In addition to the fibrous tissue, such as is found in pure fibromata, they present numerous long spindle-shaped cells, which were shown by Virchow to be involuntary muscular fibre cells, and consequently these tumors are classed by many writers under "myomata" or "myofibromata." In the tumors of old women these muscle-cells frequently undergo atrophy, and the tumor then presents the appearance of a pure fibroma. Fibroid tumors of the uterus either project into the cavity of the organ, forming uterine polypi, or into the cavity of the pelvis. They are liable to softening and ulceration, accompanied by much hæmorrhage when they assume the polypoid form. Under any circumstances they frequently calcify, and occasionally, as above stated, soften, forming enormous cysts. Somewhat analogous tumors are found in the prostate gland in the male.

The *Treatment* of fibromata is in a great measure palliative; but when they are so situated as to admit of removal, as in the neck, lower jaw,

antrum, mamma, or subcutaneous tissue, they should always be extirpated.

Tumors closely resembling fibromata in naked eye appearance and consistence, have been known to recur after removal with much tendency to ulceration, sloughing, and hæmorrhage. They may even give rise to secondary deposits in internal organs. These tumors will always be found on microscopic examination to present the signs of one of the forms of sarcoma to be described hereafter. Pure fibromata are invariably benignant.

c. **Enchondroma — Chondroma — Cartilaginous Tumors.** — These tumors have been carefully studied by Müller, and investigated by Paget. They form an exceedingly interesting group, being of comparatively frequent occurrence, and sometimes assuming a large size.

In structure enchondroma may closely resemble normal cartilage (Fig. 279), either of the hyaline or fibrous variety. The cells vary much in size and shape. In the most typical form they are large ($\frac{1}{500}$ to $\frac{1}{800}$ inch), round, oval, or polygonal in shape, and containing a single large nucleus and nucleolus, and sometimes inclosed in a capsule as in normal cartilage. Occasionally the cells are found to be irregular in shape and branched, the processes of one cell communicating with those of another, as in a myxoma. This form resembles the cartilage normally found only in the cuttle-fish. The matrix may be hyaline, as in normal fœtal or articular cartilage, or fibrillated. It varies much in density, occasionally being so soft as to give the tumor a false sense of fluctuation. This softness is usually found in the more rapidly growing varieties. The tumor may consist of a single mass of cartilage, or may be composed of innumerable lobules, bound together by vascular bands of fibrous tissue. It is this vascularity that often forms the most striking difference between normal cartilage and enchondroma. Its surface may be covered by a distinct fibrous layer, sharply limiting it from the surrounding tissues,

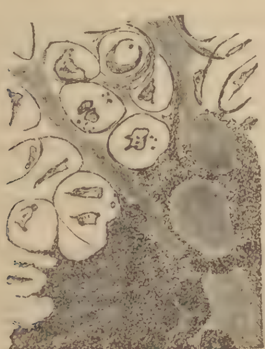


Fig. 280.—Enchondroma (188 diam.). From a small tumor near, but distinct from, an ossifying enchondroma of the femur, shows the variety in shape of the cells and capsules. At the upper part calcification is taking place involving first the matrix and then the cells. Fig. 281.—From an enchondroma of the finger; matrix faintly fibrillated.

or the mass of cartilage may be surrounded by a vascular zone of embryonic tissue, sometimes composed of round, and sometimes of spindle-shaped cells, which may infiltrate and invade the surrounding structures. It is probably this variety that assumes the characters of malignancy. Enchondromata are liable to various secondary changes. Thus they may

undergo true ossification. The ordinary pedunculated or spongy exostosis is usually found to be covered with a thick layer of cartilage, so that it might be spoken of as an ossifying enchondroma. Calcification is a far more common change than true ossification (Fig. 279). Not unfrequently mucous softening takes place in the matrix. The cells in this condition float free in the fluid, and undergo degeneration, becoming filled with large globules of fat. This mucous softening may be so extensive as to give the once solid tumor the appearance of a thick-walled cyst. In a case of a very large enchondroma of the ribs under my care a few years ago, I was enabled to make the diagnosis by microscopic examination of a small quantity of such fluid, removed by means of the aspirator. Cartilage may also be found mixed in one tumor with other structures. Thus the cartilaginous tumors of the parotid region are seldom, if ever, pure, but contain mingled together the structures of myxoma, adenoma, and enchondroma. Enchondroma and sarcoma are not infrequently found combined. Encephaloid cancer and enchondroma are said to have been found combined in the testes.

Cartilaginous tumors may appear under two distinct forms; most commonly as innocent growths, but in other cases assuming a malignant tendency and appearance. These two forms present different signs. In the first case, the enchondroma occurs as a hard, smooth, elastic, ovoid, round, or flattened tumor, often nodulated, of small or but of moderate size, seldom exceeding that of an orange, and growing slowly without pain. In the second form, it approaches in its character to malignant disease, growing with extreme rapidity, attaining an enormous size within a few months, and contaminating the system by the deposit of secondary enchondromatous growths in internal organs; in these circumstances, it would appear to have occasionally been mistaken for the rapidly spreading forms of encephaloid disease. The infecting variety will always be found to be surrounded by a zone of soft embryonic tissue.

When these growths attain a large size and soften as above described, the skin covering them may become duskily inflamed, eventually slough, and form fistulous openings, through which a thin jelly-like matter is discharged. In some cases it would appear that large tumors of this description, softening in the centre, and becoming elastic and semifluctuating, have been mistaken for cysts, and have been tapped on this supposition. In small enchondromata the opposite condition more frequently occurs, the tumor becoming indurated, and undergoing ossification.

Locality.—Most frequently enchondroma occurs in connection with some bone. It is most frequent in the metacarpus and phalanges of the fingers (Figs. 282, 283). It is rare, in this situation, to find only one bone or phalanx affected; the tumors are almost invariably multiple. They form hard or elastic rounded knobs, seldom larger than a walnut or a pigeon's egg. They never ossify, but not unfrequently calcify. Large enchondromata are most commonly met with in or upon the head of the tibia or the condyles of the femur, forming in these situations rapidly increasing growths of considerable magnitude. Enchondromata also are found on the ribs and bones of the pelvis, in the intermuscular spaces of the neck, thigh, and leg; in connection with the sheaths of tendons, and occasionally in glands; but in this last situation they are seldom, if ever, pure, being mixed with myxoma, adenoma, or sarcoma, and it is said by some, occasionally with carcinoma. It is a curious fact, that enchondromata never arise in connection with pre-existing carti-

lage. When connected with the bones, enchondroma may spring from the periosteum, gradually enveloping, absorbing, and eventually destroying, the osseous structures, though at first not incorporated with them. It has then been distinguished as "perichondroma." This is its usual mode of origin when occurring in the femur or tibia; when seated on the short bones, especially on the metacarpus and phalanges (Figs. 282, 283), it commonly springs from the interior of the osseous structure,

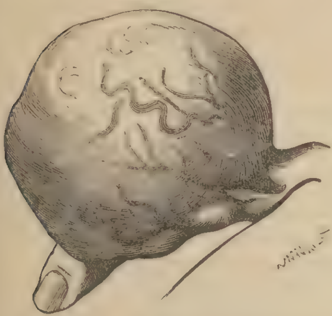


Fig. 282.—Large Enchondroma of Index Finger.

Fig. 283.—Ordinary Enchondroma of Finger.

which becomes expanded and absorbed, and is involved in the general mass of the tumor. When occurring in cellular regions unconnected with bone, the enchondroma is softer, and does not present such distinct cartilage-cells as the osseous enchondroma. Most frequently these enchondromatous masses occur in childhood, or shortly after puberty, appearing to arise from an overgrowth of the cartilaginous element of the osseous system at this period of life.

The *Treatment* consists either in excision of the tumor, or in amputation of the affected part. Excision may be practised when the tumor is seated in the parotid region, or otherwise unconnected with bone. When forming part of the osseous structures, it cannot well be got rid of without the removal by amputation of the bone that it implicates. When it occurs in the hand, removal of the affected fingers and metacarpal bones, to an extent proportioned to the amount of the disease, will be required; but it should be remembered that in this situation enchondromata are always perfectly innocent, and consequently the operation should not be performed if the finger be useful to the patient, unless he is willing to sacrifice an useful finger to get rid of an unsightly deformity.

In Fig. 26 may be seen the kind of hand left after operation in the case from which Fig. 283 was taken. If, in these circumstances, excision of the tumor only be attempted, it will be found that the whole mass cannot be removed, and that it rapidly grows again; or that the wound formed by the operation remains fistulous and open.

Most commonly a permanent cure is effected by the ablation of the tumor in one or other of these ways; but cases have occurred amongst the more rapidly growing varieties of enchondroma, especially when seated in glands, and when the growth is not purely cartilaginous, in which recurrence has taken place after operation, the secondary tumor being softer than the primary, with a close approximation to malignancy in appearance and action.

(*d*) **Osteoma. Exostosis. Bony Tumor.**—In order to render the review of the different varieties of tumor complete, it will be necessary-

sary briefly to mention the osteoma in this place, though their clinical characters will be more fully treated of in the chapter on the Diseases of Bones. In the first place, it is necessary accurately to distinguish mere calcification from the formation of true bone. The former is extremely common, the latter somewhat rare. Bone appears in tumors under four chief conditions; 1st, as the result of the ossification of a fibroma; 2d, of a sarcoma; 3d, of an enchondroma; and 4th, as a special growth covered with a firm layer of periosteum. Bone has also been described as occurring in connection with carcinoma; but this assertion requires confirmation since the separation of sarcoma and carcinoma. Only the last two forms mentioned above are usually spoken of as bony tumors or exostoses. They differ essentially from each other in their seat and consistence, as well as in their mode of growth. Those developing from cartilage or spongy exostoses, are situated almost invariably in the immediate neighborhood of an epiphysis, and rarely, if ever, start into growth after the twenty-fourth year; those developing from a fibrous periosteal covering, ivory exostoses, are of extreme and remarkable density, and are usually seated on flat bones, such as those of the head, face, scapula, and pelvis. Both these growths closely resemble normal bone in structure, the spongy exostosis exactly agreeing with the cancellous tissue of the extremity of a long bone, and the ivory or hard exostosis corresponding to the petrous portion of the temporal, the lower jaw, or the compact tissue of a long bone. Both forms are invariably non-malignant.

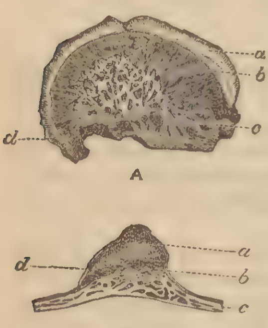


Fig. 284. — Pedunculated exostoses (natural size).
A. From femur of a b y.
B. From scapula of a child three years old.
a. Hyaline cartilage.
b. Layer of imperfect ossification.
c. Well-formed spongy bone.
d. Periosteum.
The drawing illustrates the different proportions which the various constituents of the tumor may bear to one another.

Spongy Exostoses, sometimes called pedunculated or cauliflower exostoses, from their shape, are most common at the upper end of the humerus and the lower end of the femur, and on the ungual phalanx of the great toe (Fig. 284). If observed during the stage of growth, they are found to be covered by a perfectly developed hyaline cartilage, which apparently grows from the perichondrium covering it, and quickly undergoes ossification at its deep surface. If the tumor be observed when all growth has ceased, it will be found to be completely bony, being composed of a pedunculated mass of cancellous tissue, covered thinly by a layer of compact bone. The cancellous tissue of the tumor is continuous with that of the bone upon which it grows, the compact tissue of the shaft being absorbed beneath the base of the tumor. Sometimes these tumors are hereditary and multiple. They scarcely ever reach a great size, and probably cease to grow if they become completely ossified.

Ivory Exostoses.—These tumors form flat rounded elevations, usually seated about the bones of the skull or face. They are covered with a fibrous membrane and are of intense hardness. Occasionally they are multiple and grow to a considerable size, and when seated on the facial bones distort the features horribly, and at last after years of suffering possibly cause death by pressure on the brain.

(*e*) **Myxoma. Mucous Tumor.**—These tumors are classed by some writers under sarcomata, as the tissue of which they are composed closely resembles the rudimentary fat of the embryo. In the adult, the vitreous body of the eye is the only part in which mucous tissue is normally found. Many tumors formerly described as colloid cancer belong properly to this class. Myxomata usually form round, oval, or lobulated masses, distinctly surrounded by a loose capsule of connective tissue. They are tense, elastic, gelatinous, frequently giving rise to a sense of fluctuation so distinct as to lead to their being mistaken for cysts. They are usually of slow growth. On section they are found to be of a delicate pink color, sometimes stained by hæmorrhages, or they may present an uniform yellowish tint. The most marked peculiarity they present on section is in the fluid which flows from the cut surface. This is abundant, glairy, and tenacious, having the appearance of thick gum water. On chemical examination it is found to contain mucous; microscopic examination shows (Fig. 285) in the purest forms of myxoma a beautiful network composed of large stellate or branched cells, the process of which freely communicate with one another. These cells are imbedded in an almost homogeneous intercellular substance, in which vessels can be clearly seen to ramify. It is seldom, however, that this structure is found as pure as this. In addition to the stellate cells, numerous small round cells (Fig. 286) are usually present, and the intercellular

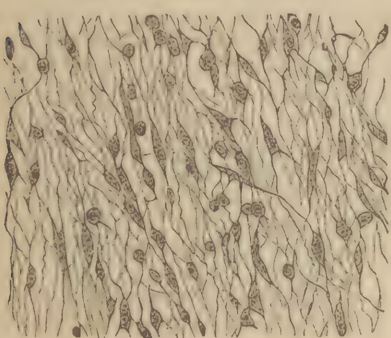


Fig. 285.—Myxoma, from a large tumor in the skin of the back (188 diam.). It will be noticed that even the round cells are connected with those which are more branched.

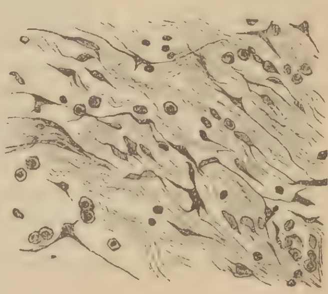


Fig. 286.—Mucous Polypus of Nose (188 diam.). The round cells vary in size and are distinct from the branched ones. The branched cells are very irregular, and the matrix somewhat fibrous.

substance is in most cases traversed by delicate bundles of fibrous tissue, sometimes containing yellow elastic fibres. The stellate cells may be smaller in some cases than in others. The peculiar feature of the growth is the mucous intercellular substance, and without this being present no tumor should be called a myxoma. Frequently tissue agreeing in all respects with that of a pure myxoma is found mixed with that of sarcoma, enchondroma, or adenoma. These tumors are spoken of as myxo-sarcomata, myxo-chondromata, &c. Myxo-chondroma, frequently containing portions of adenoma, forms the ordinary parotid tumor. Occasionally a development of true fat-cells may take place in the central parts of a myxoma, thus indicating, as Virchow thinks, the relation of these tumors to embryonic fat. A few years ago I saw in consultation a case of an enormous abdominal tumor, which proved upon examina-

tion after death to be a pure myxoma, weighing at least thirty pounds. the central parts of which contained an abundance of true adipose tissue. Such tumors as these have been spoken of as myxo-lipomata. Myxomata may occur in any part of the body. When superficial they often assume a polypoid form as in the ordinary mucous polypus of the nose (Fig. 286). Myxomata are not unfrequent in the subcutaneous cellular tissue, in nerves they form one variety of false neuroma, and they are occasionally met with in glands. Myxomata are usually absolutely non-malignant, but occasionally they recur locally after removal. If left untreated, they may cause death by ulceration of the skin taking place over them, leading to sloughing of the tumor with profuse hæmorrhage and foul discharge. Occasionally they may prove fatal from pressure on important organs, as in the case of the abdominal tumor above mentioned. The *Treatment* consists in the removal of the growth whenever an operation is possible.

III. TUMORS WHICH RESEMBLE IN STRUCTURE, MORE OR LESS PERFECTLY, ONE OF THE MORE COMPLEX TISSUES OF THE BODY.

A. **Myoma. Muscular Tumor.**—These tumors are of two classes; those containing striated and those containing non-striated muscular fibre. Striated muscular fibre has, at present, only been found in a few congenital tumors, and is merely a pathological curiosity. Non-striated muscular fibre is found in abundance, as mentioned on a previous page, in the so-called fibroid tumors of the uterus, and of the prostate, but it is always associated with large quantities of fibrous tissue, so that the tumor is more properly spoken of as a myo-fibroma. The older tumors are found to be composed almost entirely of fibrous tissue, the muscular fibre-cells having undergone atrophy. Pure myomata have, in very rare cases, been found in connection with the œsophagus. Fagge has recorded an interesting case of this, which was accidentally discovered after death at Guy's Hospital. It gave rise to no symptoms during life, although the tumor was as large as a good sized egg. Myomata are always non-malignant.

B. **Neuroma. True Neuroma. Nervous Tumor.**—The term neuroma is clinically applied to any tumor growing on a nerve, whether it be a fibroma, myxoma, sarcoma, or true neuroma. The term should strictly be limited to those tumors in which there is an actual new growth of nervous tissue. Tumors containing newly formed nervous tissue are rare. Neuromata composed of gray matter (non-medullated fibres and ganglionic tissue) have been described, but they are so infinitely rare, that they need no further mention here. The vast majority of true neuromata are composed of bundles of medullated or white nerve fibres, interlacing with each other, or sometimes rolled up into masses, and separated by connective tissue, more or less rich in small cells. True neuromata occur only in connection with nerves. The bulbous extremities of nerves, often seen in stumps after amputation, are said by Valentin, Lebert, and others, to be specimens of true neuromata. True neuromata occur also without previous injury of the nerve. They are then frequently multiple. They are not diagnosable in any way from other firm tumors of nerves. They are sometimes painful and tender, and sometimes not. The most characteristic sign of any tumor seated on a nerve is, that when the nerve upon which it is seated is put on the stretch by the position of the part, the tumor is almost immovable in a direction parallel to the course of the nerve, while it is more or less freely movable in the transverse direction. True neuromata are always non-malig-

nant, and should not be interfered with in any way unless they give rise to serious inconvenience from pain.

C. **Angioma. Vascular Tumor.**—Under the name of angiomata are included only such tumors as are composed of vascular tissue of new growth, and not such swellings as arise from the dilatation of pre-existing vessels. The so-called cirsoid aneurism, or aneurism by anastomosis, being supposed to be due chiefly to a dilatation of pre-existing arteries, although doubtless accompanied by some new formation of vessels, is not usually included amongst angiomata, nor are the swellings formed by convoluted masses of varicose veins. True angiomata are usually divided into two classes:—*the plexiform angioma or telangiectasis*, and *the cavernous angioma*. The *plexiform angioma* is composed of a mass of tortuous and dilated capillaries bound together by connective tissue. The blood-vessels comprising it are normal in structure. This forms the ordinary superficial nævus, mother's mark, or port-wine stain. It is, probably, always congenital. The *cavernous angioma*, or erectile tumor, resembles in structure the corpus cavernosum penis, being made up by spaces communicating freely with each other. The walls of the spaces are composed of fibrous tissue, and are lined with an endothelium resembling that of a vein (Fig. 287). These tumors are sometimes dis-

Fig. 287.—Nævus.

A. (188 diam.) infiltrating fat. The shaded bands represent vessels out of focus, the ends of some of them being shown in transverse section.

B. (454 diam.) shows the endothelium apparently almost obstructing the lumen of the vessels as the result of their contraction.

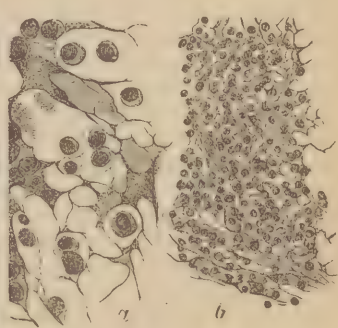


Fig. 288.—Lymphadenoma.

a. (454 diam.) Some of the cells have been removed to show the arrangement of the stroma.

b. (188 diam.) shows general arrangement.

tinctly circumscribed, and enclosed in a loose capsule of connective tissue; in other cases they are diffuse. They are rarely if ever congenital, usually arising in young adult life. They are most common in the subcutaneous tissue, but have also been met with in the liver, spleen, and other internal organs. The mode of origin of these tumors is doubtful.

The symptoms and treatment of vascular tumors will be fully described in a subsequent chapter.

D. **Lymphangioma, Tumor composed of Lymphatic Vessels.**—These excessively rare tumors are composed of dilated lymphatic vessels communicating with each other, like the spaces of the cavernous angioma, the cavities containing lymph instead of blood. Virchow has

described them as occurring congenitally in the tongue, forming one variety of hypertrophy of that organ (macroglossia). They are also said to have been seen forming pale, compressible, congenital tumors of the skin.

E. Lymphadenoma. Tumor composed of Lymphatic Tissue. Lymphoma.—Lymphadenomata are composed of tissue exactly resembling that of the follicles of the lymphatic glands, lymphoid or lymphatic tissue, the so-called "adenoid tissue" of His; but to avoid confusion, the term "adenoid" should never be used in connection with this structure, but reserved for tissues resembling those of the secreting glands. Lymphoid tissue (Fig. 288) is characterised by a delicate reticulate stroma, in the meshes of which are packed numberless cells, in every way resembling the white corpuscles of the blood. The stroma is composed of fibrous tissue containing a few oval nuclei scattered through it, especially where the bands cross each other. The stroma may, in some cases, be increased in amount and thicker than that normally found in lymphatic glands. The vessels are abundant and in close connection with the stroma. To the naked eye these tumors are white in color, sometimes stained by hæmorrhages. They are soft and often brain-like, and, from the readiness with which the cells are separated from the stroma, they may yield a milky juice on scraping. Thus they closely resemble encephaloid cancer in appearance. They vary in size from a pin's head to a fœtal head. They are sometimes circumscribed, as when they are situated in a lymphatic gland and have not extended beyond its capsule, but more usually they are diffuse. They occur at any age, but are most common in young adult life. They usually grow in connection with pre-existing lymphoid tissue, and, as this has been shown to be widely disseminated through the body, they may occur at almost any part. Lymphadenomata are chiefly found in connection with the diseases known as leucocythæmia, or that called "*adénie*" by Trousseau. The former of these is characterised by a great increase of white corpuscles in the blood, with anæmia and general debility, and the latter by the presence of the tumors without these symptoms being present. For the symptoms of these diseases, the reader must refer to works on Medicine. The tumors form in the lymphatic glands, liver, spleen, kidneys, and other organs, and they have been occasionally met with in bones. They most commonly come under the observation of Surgeons when situated in the lymphatic glands or bones. The glands of the neck and axilla are most frequently affected. They form painless swellings, usually firm in consistence, slowly growing, and are at first indistinguishable from simple chronic inflammatory enlargement. As they increase in size the glands fuse together, forming large nodular masses. They show no tendency to soften or suppurate. After a time they may cease to grow. In the thorax such tumors may cause death by pressure, and the same has been said to occur in the neck. From what has been above said, it is evident that the diagnosis of these growths from simple hypertrophy or chronic inflammation of lymphatic glands, is in the early stages a matter of great difficulty. The great number of the tumors, the absence of any source of local irritation, and the fusing together of the enlarged glands, are important signs in the later stages, accompanied by the symptoms of general weakness. If the glands cease growing and the general health be fairly good, the tumors may be removed by operation. In other cases, constitutional treatment alone must be relied upon. A few years ago I removed a tumor of this kind, as large as a fist, from the axilla of a woman aged 30. She had also a

chain of enlarged glands in the neck. She suffered from some debility, but had no excess of white corpuscles in the blood, or enlargement of the spleen.

F. **Papilloma. Tumor resembling the Papillæ of Skin or Mucous Membrane.**—A papilla is a more or less pointed projection composed of areolar tissue, surrounding a capillary loop and covered by epithelium, which may consist of many layers, as in the skin, or of only one as in the intestine. Lymphatic spaces or capillaries are also normally present in the areolar tissue. The tumors which pass under the name of papillomata are usually mere hypertrophies of the normal papillæ of the part on which they grow, and are covered by the variety of epithelium normal to the part. The papillæ of which they are composed differ from those normal to the part in size, shape, and vascularity. Thus, instead of merely microscopic papillæ, such as are normal to the skin, we may have growths sometimes reaching the size and presenting the appearance of the head of a good-sized cauliflower. Instead of simple papillæ, we may have branched growths subdividing again and again, and connected with the parent tissue only by a narrow stalk. The vessels of these growths are always abundant, and frequently dilated to a considerable size. The connective tissue forming the basis of the papillæ is more or less crowded with small round cells, according to the rapidity of the growth. Sometimes the deeper layers of the epithelium are darkly pigmented. Malignant tumors of various kinds when seated on a free surface may assume a papillary form, but these must not be confounded with papillomata. On the other hand, a papilloma may by invisible degrees merge into an epithelioma or adenoid cancer, as the case may be, the distinction between them sometimes not being possible, even with the help of the microscope. It may, however, be broadly stated that so long as the tumor maintains a simple papillary form, the epithelium being purely superficial, and showing no tendency to burrow between the papillæ into deeper parts, and so long as the base of the tumor is not composed of masses of small round cells infiltrating the surrounding structures, we may at least hope that the tumor is non-malignant. In other cases, such as the common warts or gonorrhœal warts, we know certainly that the growth is simple. Papillomata vary in hardness and softness, according to the parts on which they grow, and the amount and nature of epithelium with which they are covered. Thus the common corn or wart, being thickly covered with horny epithelium, is hard, while the papillomata of the rectum, being thinly covered with columnar epithelium, are always soft.

The chief forms of papilloma are:—corns, simple warts, condylomata, and mucous tubercles, and some forms of polypi and villous tumors.

Corns consist of an undue development of cuticle, with a slight increase of the vascularity of the subjacent cutis; subsequently the papillæ themselves become enlarged, especially when the irritation has been prolonged or considerable. A soft corn is merely one which from its situation is kept constantly moist, so that the newly formed scaly epithelium, instead of forming a dense crust, peels off, leaving the vascular and sensitive papillæ but thinly covered.

Warts are the result of a primary hypertrophy of the papillæ, accompanied by the formation of new vessels, and leading to a great increase in the development of the epidermis, which forms laminated strata, and sometimes produces masses with a concentric arrangement of the cells, closely resembling the nest-like structures seen in epithelioma. The true warts are most commonly found on the skin, and are then often very

hard and horny; sometimes they may develope a long horn-like growth. Softer varieties are, however, found on the muco-cutaneous surfaces, especially of the prepuce and vulva, and are usually of a specific origin. They may also occur on the mucous membrane of the mouth or soft palate. Warts may be the result of a local irritation, but in many cases they appear to depend as much upon some constitutional condition.

The warty growths from the vulva, as the result of gonorrhœal irritation, may reach the size of a fœtal head. Simple warty growths are not uncommon in the larynx. Simple continuous warts are often pigmented (Fig. 289), being of a bluish-black color. In these the papillæ may not

Fig. 289 —Papilloma of Soft Palate (40 diam.).

a. Superficial epithelium, containing a few vessels which are cut transversely.

b. Younger epithelium: in the deeper parts the cells are more deeply stained and radiate from the centre.

c. Connective tissue forming the papillæ, into the ramificaiions of which it is prolonged.

d. Vessels cut obliquely.

be evident to the naked eye, but the microscope shows them to be composed of greatly enlarged papillæ, the spaces between which are filled with epithelium.

In **Condylomata and Mucous Tubercles** the enlarged papillæ are soft, and contain a great abundance of small round cells, giving evidence of their rapid growth. They occur about the anus and in the perinæum and folds of the nates, as well as occasionally in the larynx and fauces. They are always dependent on a syphilitic taint. When situated on the mucous membranes, they are often pointed, somewhat pendulous or nodulated on the surface, very vascular, and bleed readily when touched; but when they occur on a muco-cutaneous surface, they are flattened, expanded, soft, and white, constituting the true condylomata or mucous tubercles.

Some forms of **polypi** are properly classed amongst papillomata. Thus the simple polypus of the rectum may be a soft papilloma bearing columnar epithelium. In some rare cases, the epithelium has been found to be scaly. The papillæ may branch again and again, the peduncle being comparatively small. It is difficult, however, to draw any accurate line between such papillomata and the adenoid cancer to be described hereafter. The common form of *villous tumor* of the bladder, frequently described as "villous cancer," should also undoubtedly be included under papillomata. This tumor is composed of long delicate processes

floating freely in the cavity of the bladder, attached only at their bases. They each consist of a dilated capillary loop, surrounded by an almost homogeneous connective tissue, containing a few scattered round or oval cells, and covered with an epithelium of an irregular shape, often resembling spindle-cells in form, and similar to that naturally lining the bladder. This epithelium is very difficult to find, as it soon separates by maceration in the urine after death. The base from which the villi grow is composed merely of fibroid tissue tunnelled in all directions by dilated vessels. These tumors, if left unrelieved, invariably terminate fatally from the abundant hæmorrhage to which they give rise, and the effect they have in interfering with the escape of urine from the bladder; but they never give rise to secondary deposits or invade surrounding structures, and are consequently non-malignant. They will be more fully described under diseases of the bladder.

The general principles of *Treatment* of these affections consist in their removal by excision, ligature, or caustics, according to their size, situation, and attachments. Excision is usually preferable when they are seated on mucous surfaces; the ligature should be used if they be large and pendulous; and caustics should be employed when they are seated on the skin or a muco-cutaneous surface.

The term "*polypus*" may perhaps be more conveniently be defined here than elsewhere. It is purely clinical, and has no pathological meaning. It merely means a tumor growing from the mucous surface lining a cavity, having a distinct peduncle and a rounded, oval, or papillary form. Thus the ordinary polypus of the nose is usually a myxoma, and the malignant polypus a sarcoma. Polypus of the uterus is a fibroma or myo-fibroma, and polypus of the rectum often a papilloma, and sometimes a form of cancer. Simple polypi are usually covered by a prolongation of the mucous membrane from which they grow. Thus the mucous polypus of the nose is covered by a membrane bearing ciliated epithelium.

Adenoma. Glandular Tumors. Pancreatic Sarcoma. Lobular Hypertrophy of Glands, &c.—These tumors resemble secreting glands in structure. Secreting glands are racemose or tubular, and consequently many writers divide adenomata into two corresponding classes.

The **Tubular Adenomata** are composed of masses of tubules resembling the crypts of Lieberkühn, some closed and some open on the surface. They are usually papillary, and seated on some parts of the intestine. They often form polypoid tumors. When simple and with well marked papillæ, they might perhaps be more properly spoken of as papillomata, and they were consequently mentioned under that class. When showing the well marked malignancy so common to these growths, they are perhaps more conveniently classed with carcinomata, either under the name of columnar epithelioma or adenoid cancer. They will, therefore, be more fully described hereafter.

The **Racemose or Acinous Adenomata** resemble in structure more or less perfectly a racemose gland, and are found always in connection with such organs (Figs. 290, 291). They are composed of rounded or irregular spaces lined with a peculiar small epithelium, somewhat square or rounded in form, and frequently many layers deep. The spaces communicate with each other, either directly or by means of more or less perfect duct-like channels. The acini, which are more or less widely separated, are bound together by fibrous tissue, bearing vessels, and containing cells varying in shape and number. In the most

typical forms the cells are merely such as are seen in ordinary connective tissues; but if the tumor be growing rapidly, large numbers of small

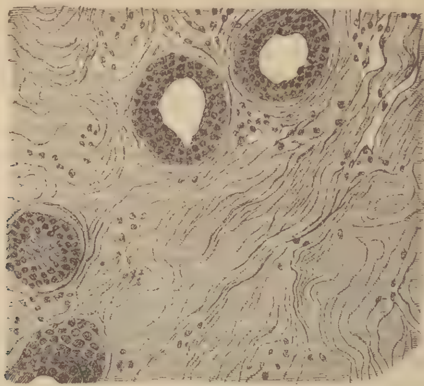


Fig. 290.—Adenoma of Mamma, of slow growth (188 diam.). Stroma bears a large proportion to the spaces, it consists of well-formed fibrous tissue. Tubes contain more than one layer of epithelium.

round or oval cells are found (Fig. 291). Sometimes the tissue between the acini may be composed entirely of spindle-cells, in fact, may have the structure of a spindle-celled sarcoma; the tumor is then often spoken of as an adeno-sarcoma. Sometimes tissue resembling that of a

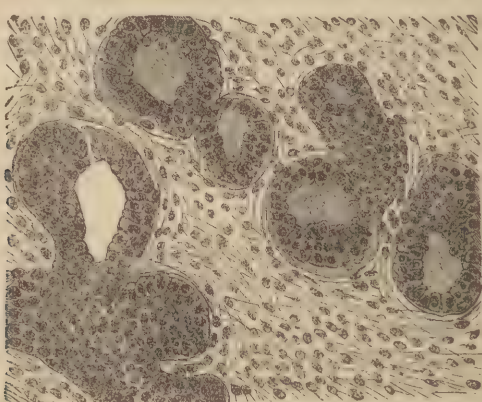


Fig. 291.—Adenoma of Mamma, rapid growth (188 diam.). This is sometimes spoken of as adeno-sarcoma; the epithelium in the acini is arranged in several layers, the stroma contains many oval cells and some fibres.

myxoma may also be found. Very frequently the acini become dilated into cysts, varying in size from a pin's head to a walnut; this forms the so-called cystic sarcoma of the mamma. Not unfrequently in such cases cauliflower-like growths, similar in structure to the rest of the tumor, may be found projecting into the cysts (intracystic growths—proligerous cysts of the mamma). These tumors are infinitely most frequent in the mamma, but they are sometimes seen in connection with the parotid, and have been recorded as growing from the racemose glands of the soft

palate, and from the lachyrmal gland. In the parotid they are often mixed with myxoma and enchondroma. They are rounded or oval in shape, perfectly circumscribed, and surrounded by a fibrous capsule. They are hard and elastic, occasionally presenting points of fluctuation when containing large cysts. They are always non-malignant, and there is no reason to believe that they ever assume a carcinomatous character. Their clinical features and treatment will be fully discussed in the chapters on the diseases of the organs in which they occur.

IV.—TUMORS COMPOSED OF TISSUE WHICH IS EITHER PURELY EMBRYONIC, OR IS UNDERGOING ONE OF THE PRIMARY MODIFICATIONS SEEN IN THE DEVELOPMENT OF ADULT CONNECTIVE TISSUE:—SARCOMATA.

The large group of tumors now classed together under the name of sarcomata includes many which were, till comparatively recently, known by a variety of other names, and grouped in other divisions: and the term sarcoma, which has now received a definite meaning, was formerly applied to almost any soft fleshy growth. Thus almost all soft sarcomata of bones, the glioma, or glio-sarcoma of the eye, sarcomata of secreting glands, and lymphatics, were formerly called soft cancer; the melanotic sarcoma, melanosis, or melanotic cancer, and the ossifying sarcoma, osteoid cancer; many firm sarcomata have been described as scirrhus, and soft sarcomata broken down by hæmorrhage as blood-cysts. Lastly, the tumors known as fibro-plastic, fibro-nuclear, recurrent fibroid, malignant fibroid, and myeloid, have all been brought into the great class of sarcomata. These tumors may grow in any part of the body. They may present every variety of consistence, color and shape; they may be circumscribed or diffuse; they may be as innocent as a fatty tumor, or as malignant as the worst form of cancer. The anatomical type of sarcoma is found in embryonic tissue, a description of which has been given in a former page (p. 717). Its pathological analogue is seen in the products of inflammation, but between these and sarcoma are many differences. The products of inflammation, supposing they live, show a tendency towards development into some more perfect tissue; but in a sarcoma the older parts of the growth show no higher development than the most recent, the same type of structure being as a rule maintained throughout. Inflammatory new growths tend speedily to limit themselves, sarcomata to grow indefinitely. In sarcoma, the individual elements are often larger than those seen in inflammation.

The cells of sarcomata vary greatly in shape and size, and it is chiefly according to these variations that this group is subdivided. The cells consist simply of a mass of protoplasm surrounding one or more nuclei, and inclosed in no cell-wall. They may be small and round, exactly resembling the white corpuscles of the blood, or large and round, looking almost like epithelium cells; they may be oval, spindle-shaped or fusiform, stellate or tailed; large mother-cells crammed with nuclei may be found, and occasionally the cells are pigmented. The intercellular substances may be scanty or abundant, homogeneous or fibrous, but under all circumstances it penetrates between the individual cells in the greater part, if not in the whole of the tumor, and thus establishes a broad distinction between these growths and carcinomata, in which the stroma forms alveolar spaces, the cells lying free within them. Occasionally the growth may ossify. The blood-vessels of sarcomata are usually abundant and thin-walled, resembling those of newly formed granulations. This makes these tumors prone to bleed, both into their own substance

and externally, and may perhaps account for the readiness with which many sarcomata propagate themselves in the direction of the circulation. Of the lymphatics of sarcomata we know little or nothing. These growths are usually prone to early degeneration. They most commonly undergo fatty degeneration in their central parts, but occasionally they may calcify; mucous softening may take place. When they reach the surface they may slough and ulcerate, forming foul cavities, sometimes of great size. Cysts are of frequent occurrence in some forms of these tumors. On scraping after a section has been made, sarcomata do not yield a milky juice when fresh, but after about twenty-four hours it can often be obtained. Some sarcomata are distinctly circumscribed and enclosed in a fibrous capsule, others infiltrate surrounding parts like the carcinomata. Sarcomata are most frequent in youth and middle life. As a rule, it may be said that sarcomata infect the system generally through the medium of the blood-vessels, while carcinoma is disseminated chiefly by the lymphatic system. This rule has many exceptions, yet nothing is more common than to see secondary growths of sarcoma in the lungs, liver, and other organs, without the lymphatic glands having ever been affected. The reverse is certainly the rule in carcinoma. It may also be broadly stated that, the more closely a sarcoma approaches to fully developed connective tissue in its structure, the less likely it is to prove malignant; but this rule also is not free from exceptions. Sarcomata vary greatly in their rate of growth, some proving fatal in less than a year, others lasting many years without attaining any considerable size. Sarcoma-tissue sometimes occurs mixed with other kinds of growth.

VARIETIES OF SARCOMA.—**Small Round-Celled Sarcoma. Granulation Sarcoma. Encephaloid Sarcoma.**—These tumors were formerly included among soft or encephaloid cancers. They resemble in structure the superficial layers of granulations, being composed of small round cells about the size of a white blood-corpuscle, or a little larger, each containing a round or oval nucleus, and imbedded in a homogeneous

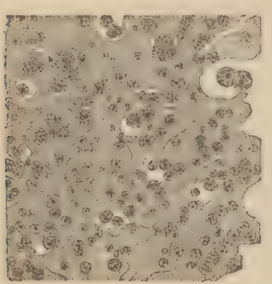


Fig. 292.—Round-celled Sarcoma, from a large tumor in the muscles round the upper end of the femur (188 diam.). The cells vary in size and have a very clear nucleus and nucleolus: the matrix which has shrunk away from the cells is faintly granular.

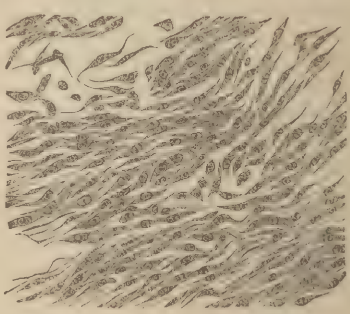


Fig. 293.—Spindle-celled Sarcoma, from subcutaneous tissue of groin (188.) diam. Cells of medium size: no intercellular fibres.

intercellular substance (Fig. 292). Sometimes the intercellular substance is scarcely perceptible, sometimes it is more abundant, as in the accompanying figure. It may be more or less distinctly fibrillated. The tumor may thus closely resemble a lymphadenoma, but on careful examination the stroma will be found not to be so clearly reticular. These

tumors are soft, sometimes even pulpy, and grey or whitish in color. They very often infiltrate surrounding parts. They are excessively vascular, and often present scattered patches of hæmorrhage or cysts resulting from extravasation of blood. They yield no milky juice when quite fresh, but when decomposition sets in it can easily be obtained by pressure or scraping. Their chief seats are in the skin, bones, subcutaneous areolar tissue, muscles, and occasionally in glands. Their diagnosis cannot be accurately made till after removal. They show a malignancy equal to that of the worst cancers. Their growth is rapid, and they early give rise to secondary deposits, especially in the lungs, and the lymphatic glands are frequently affected.

One form of small round-celled sarcoma has been described by Virchow under the name of **Glioma**, from its resemblance in structure to the neuroglia or connective tissue of the brain. It is composed of an excessively delicate areolar stroma, having round cells imbedded in its meshes. These tumors vary much in consistence, being sometimes soft and sometimes quite firm. They occur almost invariably in connection with the nerves or nervous centres. The tumor formerly known as soft cancer of the eyeball is in fact a glioma arising from the retina. It is most common in young children, and frequently runs a malignant course, projecting beyond the eyeball, infiltrating surrounding parts, and giving rise to secondary deposits.

Spindle-celled Sarcoma. Fasciculated Sarcoma. Recurrent Fibroid Tumor. Fibro-plastic Tumor.—These tumors are composed of spindle-shaped, fusiform, or oat-shaped cells, either lying closely in contact with each other or separated by a homogeneous or fibrous intercellular substance (Fig. 293). The cells vary greatly in size in different tumors, but are usually tolerably equal in the same growth. They may be little more than $\frac{1}{1000}$th inch in length, or they may reach entirely across the field of the microscope. This has given rise to the distinction between large and small spindle-celled sarcomata. The intercellular substance is usually more abundant and more fully developed into fibrous tissue in the small than in the large-celled growths; and it is the former, therefore, that gradually merge into fibromata, so that it is often difficult to determine under which heading to class them, and some writers have given them the name fibro-sarcoma. All spindle-cells, large or small, contain an oval nucleus with one or more nucleoli. The cells are usually arranged in bands crossing each other in various directions, often giving the growth a fasciculated or fibrous appearance. The vessels, as in other sarcomata, are abundant and thin-walled.

The *small spindle-celled sarcomata* are usually firm in consistence, and of a pinkish or white color, the central parts being yellow from fatty degeneration. Occasionally they contain cysts filled with straw-colored fluid; and they may closely resemble in aspect the common fibroid tumor. They form by preference in fibrous structures, as fasciæ, skin, or tendons. They may occur in inter-muscular spaces, or occasionally in the sheaths of nerves. Thus I amputated the leg a few years ago for a large tumor of this kind seated on the posterior tibial nerve. Though these tumors are usually distinctly circumscribed and sometimes encapsuled, and run a perfectly innocent course, in many cases they show an extraordinary tendency to local recurrence after removal; but it is rare for them to give rise to secondary deposits in internal organs. Paget describes these growths under the name of *recurrent fibroid tumors*, and relates several instances of them. One was a tumor of the upper part of the leg, which between 1846 and the end of 1848 had been removed five

times, and reappeared for the sixth time after the last operation, when, as it had become large and ulcerated, amputation was deemed advisable; this procedure, however, was followed by death. The examination of the third tumor presented "very narrow elongated, caudate, and oat-shaped nucleated cells, many of which had long and subdivided terminal processes:" in the last removed tumor, the cells were generally filled with minute shining molecules, as if fatty degeneration had taken place. In another case, a tumor of the shoulder had been removed, and returned four times between May, 1848, and December, 1849, reappearing in the following year for the fifth time; it, however, after a time became stationary, and many years afterwards the patient, but for the presence of the tumor, might be considered to be a strong and healthy man. Paget also relates a case in which, between 1839 and 1851, Syme removed a tumor of this kind five times from the upper part of the chest: it recurred a sixth time and was followed by death. He also refers to a case by Gluge, in which a similar tumor was five times removed from the scapula, its sixth reappearance being followed by death. The most interesting of all is a case by Maclagan, in which four removals were performed in the course of thirty-six years, twenty-three years intervening between the second and third removals, and eleven between the third and fourth. Since this form of tumor was first described by Paget, a number of instances have been recorded by British and continental Surgeons. These recurrent tumors appear to become more malignant in the later than in the earlier recurrences, becoming more painful, rapidly degenerating, and giving rise to an ulcerating fungus, which eventually proves fatal by exhaustion and hæmorrhage. The cells will then be found to have become larger, and the intercellular substance softer and devoid of fibrillation; and, in fact, they merge into the large-celled form of spindle-celled sarcoma.

Large spindle-celled sarcomata, formerly often spoken of as fibro-plastic tumors, are much softer than the variety last described. They are usually of a pinkish color, frequently stained dark red in parts from extravasations of blood, and if of any size, their central parts are opaque and yellow from the effects of fatty degeneration. They yield more or less transparent viscid juice on scraping, mixed with fragments of the growth. They may be distinctly circumscribed and encapsuled, but not infrequently they invade surrounding parts. They frequently contain cysts of some size, sometimes filled with straw-colored fluid and sometimes with blood or a blood-colored liquid. These tumors form frequently in connection with bones, especially commencing under the periosteum of the shafts of long bones or about the bones of the face or nose. A few years ago I amputated a thigh at the hip-joint in University College Hospital, for a large tumor of this kind growing beneath the periosteum of the femur, and in another case the arm was removed by Heath for a similar growth. Both had caused spontaneous fracture of the bone, and both ultimately proved fatal from internal deposits. These tumors when affecting bone must not be confounded with the myeloid, which they closely resemble. Large spindle-celled sarcomata also grow from fasciæ and intermuscular spaces, and not unfrequently from glands, especially the mamma, and they may be found in rare cases in almost any situation. They very often run a malignant course, giving rise to secondary deposits in internal organs. Their tendency to local recurrence after removal is very great. In some cases the structure may somewhat change with repeated recurrences, the later growths always showing signs of more active development and deviating more and more

from the normal type of spindle-celled growth, such as is found in the fibroid tissue of cicatrices. This is clearly shown by a case which occurred under my care at University College Hospital. A tumor as large as a full-sized turnip was removed from the shoulder of a middle-aged man, and was found to be slightly connected with the spine of the scapula. On examination, it presented all the characters of a spindle-celled sarcoma, consisting almost entirely of densely packed fusiform cells, with oval or oat-shaped nuclei. A small mass reappeared before the wound had completely healed, and on examination presented a much larger proportion of oval cells and spindle-cells, now having double nuclei. It recurred a second time, and now but few well-formed spindle-cells were found, but the tumor was chiefly composed of oval and flask-shaped cells, or rather masses of protoplasm, in which numerous nuclei were imbedded. A portion of the spine of the scapula, which was removed with the tumor, showed that the growth had sprung from the cancellous tissue of the bone.

From what has been said above, it will be seen that the spindle-celled sarcomata form a very large and important group of tumors, varying greatly in clinical characters and structure, but all resembling each other in the broad feature of the spindle-cell forming the predominant element. As to their *prognosis*, it may be broadly stated that the more they approach the structure of the spindle-celled growth found in cicatrising wounds, the less likely they are to give rise to general infection of the system; but that even the simplest may recur locally after removal, and consequently too guarded a prognosis cannot be given in such cases.

Oval-celled Sarcoma may be looked upon as merely an extremely rapidly growing and malignant spindle-celled tumor. Thus we saw in the case just mentioned, that as the rapidity of the growth increased with each recurrence, the spindle-cells became replaced by large oval cells with two or more nuclei. Sarcomata may occur primarily, presenting similar features. They are soft, rapidly growing, and rarely completely circumscribed. They are of a delicate pinkish color, and yield an abundant slimy albuminous fluid on section. I have twice had occasion to remove such growths from the neighborhood of the mamma. In one case it recurred locally after the wound had healed, and in a short time formed an enormous tumor, larger than the patient's head. She refused a second operation, and the case soon terminated fatally. In the other, although a large portion of the pectoral muscle was removed with the tumor, it recurred before the wound healed, and, in spite of the free application of caustics, grew with enormous rapidity, in a few weeks forming a fungating mass as large as a fœtal head.

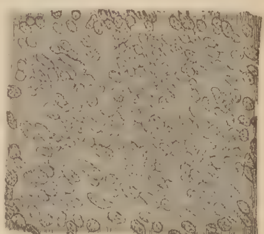


Fig. 294.—Oval-celled Sarcoma (188 diam.).

Myeloid or Giant-celled Sarcoma was formerly often classed under fibro-plastic tumors, and sometimes probably as soft cancer. It was described by Abernethy under the name of "albuminous sarcoma." It was first fully described by Lebert, and its clinical and anatomical characters have been carefully investigated by Paget. It is nearly related to the spindle-celled group of sarcomata.

The most characteristic feature of myeloid tumors is the presence of large, many-nucleated masses of protoplasm—the so-called myeloid cells—somewhat resembling the cells found in the marrow of fœtal

bones (Figs. 295, 296). They are often of great size, sometimes $\frac{1}{100}$th or even $\frac{1}{50}$th inch in diameter. They are often extremely irregular in shape, having processes projecting from them in all directions. The nuclei

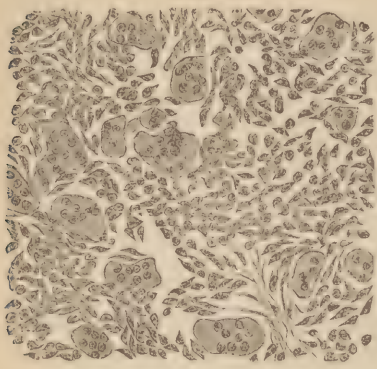


Fig. 295.—Myeloid Sarcoma from the Lower Jaw (454 diam.). The small cells have shrunk away from the myeloid cells, the former vary from round to spindle shape.

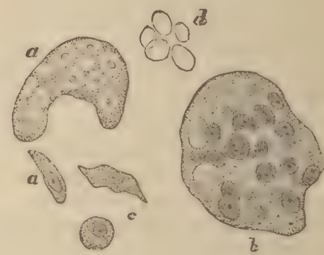


Fig. 296.—Constituents of a Myeloid Tumor (454 diam.).
a a'. From a fresh scraping.
b, c. From a stained section.
d. Transparent nuclei from a fresh scraping.

vary from eight or ten to thirty or forty in number, and are oval in shape, with distinct and highly refracting nucleoli. These myeloid cells are embedded in masses of spindle-shaped or roundish cells, between which there is either no intercellular substance, or merely a small quantity of homogeneous gelatinous material. These growths are extremely vascular, so much so, that the whole mass not unfrequently pulsates distinctly. Myeloid tumors frequently contain cysts, often of considerable size. On section they present a soft gelatinous appearance and brittle structure; they usually yield a slimy fluid on scraping, mixed with fragments of the tumor; they are of a pink color at their growing margin, while the central parts are of an opaque yellow from fatty degeneration. The intermediate parts usually present patches of a dark maroon color, caused by extravasations of blood. Occasionally patches of ossification may be found. Myeloid tumors grow almost exclusively from bone, and by far most frequently from the medullary cavity or cancellous tisue at the head of a long bone. They grow to a large size, sometimes slowly and gradually, and at other times with very great rapidity. The growth gradually causes absorption of the bone, but at the same time a new deposit takes place from the periosteum, so that the tumor is enclosed in a thin bony shell, which, on pressure, yields the peculiar sensation known as "egg-shell crackling." On reaching a cartilage-covered surface it pushes the cartilage before it, but rarely if ever perforates it. On examination of such a tumor after removal, a bony plate will frequently be found separating it from the medullary canal. At other times it may extend a long

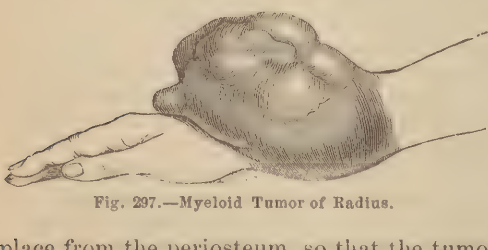


Fig. 297.—Myeloid Tumor of Radius.

distance, infiltrating the medulla. Myeloid tumors are most common at the lower end of the femur, the upper end of the tibia, and the upper end of the humerus. They also, when growing from the jaw-bones, form one variety of epulis. I have removed them from the lower end of the radius, and from the metacarpal bones (Figs. 297, 298). In the majority of cases they may be safely removed without the prospect of recurrence, but occasionally, without any apparent reason, they return after removal. The true myeloid rarely, if ever, gives rise to secondary deposits in the lymphatic glands or internal organs. Myeloid tumors are said to have been seen in the parotid region and the mamma, but this is doubtful.

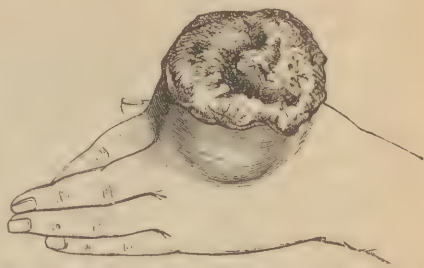
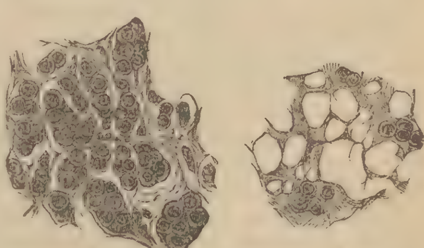


Fig. 298.—Myeloid Tumor of the Metacarpal Bones of the Index and Middle Fingers. Successful Removal of those Bones and Fingers.

Ossifying and Osteoid Sarcomata.—These tumors were formerly classed amongst the cancers, under the name of osteoid cancer. Almost any form of sarcoma may undergo ossification. Thus round-celled, spindle-celled, and myeloid sarcomata may occasionally show abundant formation of bone. The development of bone in these growths seems to give rise to no radical change in their nature. They still show the same tendency to unlimited growth, and sometimes the same liability to recur locally or to give rise to secondary deposits in distant parts. The secondary deposits develope bone like the original growth. The bony parts of these tumors usually present the appearances of true bone, but somewhat irregular in structure. Occasionally tumors growing from bone are met with, which present the structure of the growing tissue found beneath the periosteum in inflammation or in normal growth; that is to say, small round or polygonal cells with simple or multiple nuclei, separated by a small amount of homogeneous or fibrillated intercellular substance. These growths readily ossify; they form beneath the periosteum, and the bone beneath is often thickened, so that the medullary canal may be obliterated. They show a considerable tendency to local recurrence after removal. In rare cases, ossifying sarcomata are found unconnected with pre-existing bone.

Alveolar and Large Round-celled Sarcoma.—In these rare tumors, which were first clearly described by Billroth, the cells are of considerable size, sharply defined, and each containing a large round nucleus (Fig. 299). They thus closely resemble epithelium-cells in appearance. They are separated from each other by a distinct and somewhat abundant fibrous stroma, but on careful examination this stroma will be found to penetrate between the individual cells. In some parts, probably from the pressure of the growing cells, the stroma



A B

Fig. 299.—Alveolar Sarcoma from Skin of Leg (183 diam.).

A. To show general arrangement.

B. After prolonged pencilling shows the intercellular as well as the alveolar stroma.

may be partially absorbed, so that the cellular elements seem to lie in alveolar spaces in immediate contact with each other, but further examination of the tumor will always show parts where the stroma and cells are closely intermixed. On carefully pencilling out the cells from a thin section, it will often be found that a delicate stroma is brought into view, passing between the individual cells and subdividing the spaces formed by the bands, which give the growth its alveolar and cancer-like appearance. In some cases, however, the distinction between these tumors and scirrhus is very difficult. Alveolar sarcomata occur chiefly in the cutis, bones, and muscles. In the cutis they form hard rounded tumors, often multiple, of tolerably slow growth, and free from pain. They lead ultimately to ulceration of the skin and the formation of an intractable ulcer. In the bones, they are more often single and of more rapid growth. Three cases affecting the cutis have occurred in University College Hospital during the last few years. In the first, three amputations had been performed for recurrence of the growth after removal, by Christopher Heath, commencing with one finger and ending with the fore-arm. The tumors, when first removed, were supposed to be specimens of scirrhus of the skin. Finally, similar tumors appeared in the cheek and scalp, and two more operations were performed. The man died shortly afterwards, and there was reason to believe that the cause of death was a similar tumor in the lung. The whole history of the case lasted more than seven years, and at no time had the lymphatic glands been affected. In the second case, Berkeley Hill amputated the leg for a number of similar tumors situated below the knee, from one of which the accompanying drawing is taken; and in the third, Marcus Beck amputated half the foot for a similar growth, which commenced at the roots of the second and third toes, and had recurred three times after removal.

Melanotic Sarcoma—Melanosis—formerly included under melanotic cancer, was specially studied by Sir Robert Carswell, who arranged it under the heads of *Punctiform Melanosis*, in which the dark pigmentary matter occurs in the shape of minute points or dots scattered over a considerable extent of surface; *Tuberiform Melanosis*, occurring in tumors which vary in bulk from a millet-seed to an egg or an orange, always assuming a globular, ovoid, or lobulated shape, and being principally met with in the areolo-adipose tissue, or on the surface of serous membranes; and *Stratiform* and *Liquiform Melanosis*, which takes place principally upon serous membranes, or in accidental cavities, where the black pigmentary matter looks not unlike Indian ink Only the second or tuberiform melanosis is truly a morbid growth, the others being merely varieties of pigmentation of pre-existing structures.

Melanotic sarcoma is usually of the spindle-celled variety, but frequently contains large numbers of round or oval cells intermixed with the fusiform cells (Fig. 300). The spindle cells are of large size, and there is no fibrous stroma. The pigment is seen as brownish granular matter in the interior of a certain number of cells, the rest remaining colorless. In the secondary tumors, it has been shown by R. J. Godlee that the new cells follow the lines of the vessels. These tumors are usually sharply circumscribed, both to the naked eye and the microscope. They are soft, sometimes often pulpy, round or oval in shape, and varying in color from dark brown to the most intense black. They arise especially from structures in which pigment naturally exist, namely, the skin and choroid coat of the eye-ball (Fig. 302). They may, however, occasionally arise primarily in the lymphatic glands. They

are of rapid growth, and occur usually in middle life. Melanotic sarcoma is one of the most malignant of all forms of tumor. The secon-

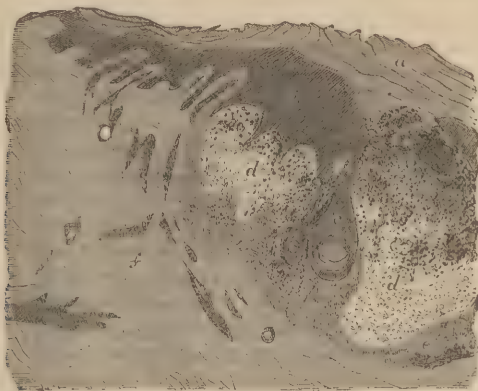


Fig. 300.—Melanotic Sarcoma commencing in the Papillæ of the Skin (Malignant Mole). (40 diam.)
a. Superficial Epidermis.
b. Deeper layers of Epidermis, which is deficient to the right of the drawing.
c. Prolongation of the Epidermis into the centre of the growth.
d. Sarcoma tissue, chiefly non-pigmented but with scattered melanotic patches.
e. Connective tissue round the tumor infiltrated with small round cells.
f. Surrounding connective tissue with vessels.

dary deposits occur in every organ and tissue in the body, and they may apparently be propagated entirely by the vascular system, the lymphatic

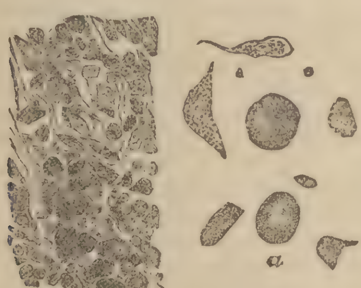


Fig. 301.—Melanotic Sarcoma, from a Secondary Tumor in the Heart. Figure to the right (188 diam.) shows the different degrees of pigmentation and variety of shape in the different cells. Figure to the left (454 diam.), from a fresh scraping, illustrates the differences in the size of the pigment-granules.

Fig. 302.—Melanosis of Eye—natural size. The eye has been divided in the antero-posterior diameter. The tumor slanted from the choroid and afterwards burst through the sclerotic.

glands escaping any contamination, or they may be distributed by both the vascular and the lymphatic systems. It may be broadly stated that if a melanotic sarcoma reach the size of a filbert secondary deposits have in all probability occurred, and no local treatment can cure the patient, although, by relieving him of one source of infection, it may retard death. Although showing this terrible general malignancy, the local malignancy of melanotic sarcoma is not great. It may reach a large size without ulcerating; it is frequently distinctly encapsuled, and, if removed freely, often does not return in the scar. The secondary tu-

mors form in every part of the body; constantly in the lungs and liver, almost constantly in the brain and spinal cord, spleen and kidneys, and subcutaneous tissue; very often in the heart, intestines, medulla of bones, and lymphatic glands. Like the cells of the primary tumor, some of the secondary growths are found to be pigmented and some not. The *diagnosis* of melanotic sarcoma is made by the color and rapidity of the growth. It must not be confounded with the simple pigmented wart. This is always of slow growth, more or less firm, pedunculated and lobulated. It must be remembered, however, that melanotic sarcoma may start from a wart of this kind, or from a congenital mole. As to true melanotic cancer, that is to say, pigmented encephaloid, it is doubtful if such a growth exists, and if it do, it must be of extreme rarity. The *Treatment* of melanosis is the removal of the tumor as soon as it is diagnosed, unless secondary deposits can already be recognized.

Psammoma is a rare form of tumor found only in connection with the membranes of the brain. The chief characteristic of these growths is the presence of small concentric calcareous globules, the so-called "brain-sand." They are chiefly composed of peculiar flattened cells. They give rise to no symptoms, except in infinitely rare cases.

Sarcomatous Blood-cysts, or Hæmatomata.—Tumors have been frequently described under the name of "blood-cysts," of which the most characteristic feature was the presence of a large collection of fluid or partly coagulated blood in a cyst, the walls of which were imperfectly defined. If the blood were evacuated by puncture or incision, free hæmorrhage, difficult to control, or, at least, speedy re-accumulation of the fluid was the only result. If seated on a limb, free excision of the cyst and its contents, or amputation, was justly looked upon as the only mode of treatment holding out any prospect of success. The nature of these tumors was not well understood; it has, however, recently been shown that in all probability they are, in the great majority of cases, soft sarcomata, broken down by hæmorrhage into their structure. The walls of these cysts are formed of a thin layer of sarcoma tissue, either of the round or spindle-celled variety. A very interesting case of this kind came under my care in University College Hospital in 1874. A healthy man, aged 40, had noticed, for about nine months, a soft swelling on the upper and outer part of the leg, which he attributed to a strain. It fluctuated distinctly; and when I first saw it, a dark red fluid was oozing from two discolored points. It was altogether about three inches in diameter and of a dark purple color. It had previously to admission been treated, first by the passage of a seton, and secondly, by being laid open and dressed from the bottom, which latter treatment had been repeated twice. On both occasions it was reported that nothing but blood escaped. I laid the tumor freely open, and turned out a large quantity of what was apparently ordinary blood-clot, and then dissected away the cyst-wall. The supposed blood-clot was found, on microscopic examination, to be composed of a mixture of the cells of a mixed, round, and spindle-celled

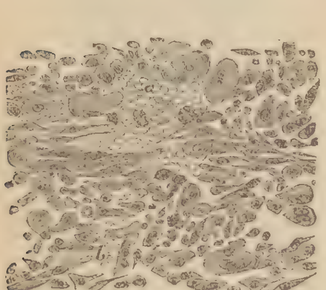


Fig. 303.—Mixed, Round and Spindle-celled Sarcoma, into which Hæmorrhage has taken place (188 diam.).
a. Recent Hæmorrhage.
b. Blood-corpuscles becoming granular.

sarcoma, with coagulated blood (Fig. 303). The wall of the cyst was found to be composed of pure sarcomatous tissue. The growth recurred before the wound was completely closed, and amputation at the knee-joint was performed, the patient making a good recovery.

Mixed Sarcomata.—Tumors are frequently seen which combine in themselves structures properly belonging to two or more distinct forms of growth. Several of these have been already mentioned. Thus the growths standing on the doubtful line between small spindle-celled sarcoma and fibroma, are spoken of as *fibro-sarcomata*. In very rare cases some of the cells of a sarcoma may develope into true fat-cells; we have then the *lipo-sarcoma*. Spindle-celled or small round-celled tissue is not unfrequently associated with cartilaginous tumors, forming the *chondro-sarcoma*. Occasionally large tracts of a tumor, the chief part of which is purely sarcomatous, may undergo mucous softening, and the cells may be more or less stellate or branched, as in a myxoma, and we have then the *myxo-sarcoma*. As before stated, the tissue between the acini of an adenoma may present exactly the structure of a spindle-celled or even round-celled sarcoma; these tumors are then sometimes called *adeno-sarcomata*. Lastly, the stroma of a cancer may be composed of cells like those of a large spindle-celled sarcoma. In tumors which are purely sarcomatous it is, moreover, very common to find a mixture of the various kinds of cells which has been described as characterising the different varieties mentioned in the preceding pages.

V.—TUMORS COMPOSED OF CELLS OF AN EPITHELIAL TYPE ARRANGED IN SPACES IN A STROMA CONSISTING OF MORE OR LESS PERFECTLY DEVELOPED FIBROUS TISSUE.

The members of this group constitute the *cancers* or *carcinomata*, and are uniformly malignant in their progress.

Cancer, Carcinoma.—Before proceeding to the individual growths forming this class, it will be desirable to say a few words upon the subject of cancer generally.[1] The term has been very vaguely applied, the older pathologists placing under this head all growths which presented a malignant aspect, intense rapidity of growth, or recurrence after operation; thus several of the tumors already described were formerly considered to be cancers. The occasional co-existence of true cancer with cartilaginous, bony, or erectile tissue, has given rise to special varieties called respectively Chondroid, Osteoid, and Aneurismal. Accidents of structure or appearance have been designated by special names, as Cystic, Villous, Fungoid, &c., and thus much confusion has resulted.

Cancers may be conveniently divided into four groups, which must not, however, be taken as possessing any positively distinctive characters, but merely as types of certain important varieties, viz.: Encephaloid, soft or acute Cancer; Scirrhus, hard or chronic Cancer; Epithelial or Integumental Cancer, and the Adenoid or Glandular Cancer, or

[1] It is not my intention to enter largely into the general history of malignant diseases, as space will not admit of my doing so; I would therefore refer my readers, who wish for further information on this interesting subject, to the works of Abernethy; the papers by Lawrence; the admirable and magnificent "Illustrations of the Elementary Forms of Disease," by Sir R. Carswell; to the excellent and copious monograph by Walshe; and to Paget's philosophic Lectures on this subject. Amongst the foreign works may be mentioned "Traité des Tumeurs," by Broca; and Billroth's "Handbook of General and Special Surgery," and "General Surgical Pathology and Therapeutics."

Tubular Epithelioma. This division will be found to facilitate the study of the numerous minor varieties which occasionally present themselves.

Viewing the four varieties of cancer above enumerated as formed upon a common type, we cannot be surprised at finding very numerous points of resemblance existing amongst them; thus one form of cancer may take the place of another, or be associated with it; encephaloid occurring after the removal of scirrhus, or being associated with a structure allied to epithelioma. This identity of seat and of recurrence, which tends more than anything else to establish a common origin amongst these tumors, has been specially pointed out by Carswell. Then, again, these tumors are all of a truly malignant character, having a tendency to induce a peculiar and similar condition of the system that goes by the name of the *Cancerous Cachexy.* In chemical composition, also, they are nearly identical, being principally composed of albumen.

We will now describe and compare the **Scirrhous** and **Encephaloid** cancers: the epithelial and adenoid forms, presenting some very marked peculiarities of structure, will be more conveniently considered apart from the others.

Microscopic Structure.—The microscopic characters of the different forms of cancer have of late years attracted considerable attention amongst pathologists. They consist, in all the varieties, essentially of the same elements, though these may differ somewhat in appearance, and in relative preponderance, in the different forms of the affection.

A cancer always presents collections of cells of an epithelial type, grouped together irregularly, in close contact with each other, and enclosed in spaces always more or less distinctly alveolar. As in a normal gland we can have no doubt where the epithelium ends and the fibrous tissue begins, so in a cancer there is a sharply defined line between the cells and the stroma. The cells are but loosely connected with the stroma and with one another, and in many cases are separated from each other by a very small quantity of fluid. If a thin section of a cancer be gently brushed under water with a camel's hair pencil, or shaken in a test-tube half full of water, the cells may be washed away and the stroma left. Its alveolar nature will then be distinctly apparent, and the fibrous stroma will be seen to bound spaces which by their communication form a cavernous system. Every cancerous tumor is surrounded by a halo of small cell-infiltration, implicating the surrounding parts, and in this mass of small round cells it is somewhat difficult to discern the exact process by which the tumor grows. It is this that has led to the great diversity of opinion as to the histological origin of cancer. In the central parts of cancers, as of sarcomata, degenerative changes are almost invariably found. These tumors yield on scraping or pressure a milky fluid, termed the *Cancer-juice*, in which cells and granules are found in varying proportions. The granules are mostly fatty, and are the result of fatty degeneration of the cells of the

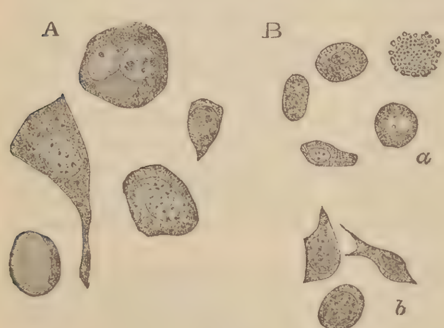


Fig. 304.
A. Cells from a large Encephaloid of the Breast.
B. Cells from Scirrhus of the Breast.
a. Stained. *b.* Unstained.
(454 diam.)

tumor. This milky juice, it must be observed, is not absolutely characteristic of cancer. It is yielded by the lymphadenomata and by all the sarcomata, provided at least twenty-four hours elapse after their removal before they are examined. At one time the cells of cancer were looked upon as characteristic of the disease (Fig. 304), and the cancer-cell was spoken of as something absolutely peculiar and diagnostic; it is now known, however, that the exact determination of the nature of a growth can only be made by careful examination, not of the cells only, but also of the stroma and of the relation of the cells to the stroma. The mode in which the tumor invades surrounding parts is also an important aid in determining the nature of the growth. The *Cells* of a cancer are extremely variable in shape and size. They may be round, caudate, and even fusiform. Many varieties of form are usually found in the same tumor, but occasionally great uniformity prevails. The size may vary from $\frac{1}{2500}$ inch to $\frac{1}{800}$ inch. The nuclei are oval and highly refracting, often placed excentrically; they are of considerable size and frequently double, while in some cases five or six may be found in the same cell. They contain bright shining nucleoli. The size of the cells is not indicative of the variety of the cancer. Thus, in some scirrhous tumors the cells may be small, and in others large, and the same may be said of encephaloid. The distinction between scirrhus and encephaloid is made not by the size of the cells, but by the relative proportions of cells and stroma in the mass. All cancer-cells are prone to early degeneration, usually becoming filled with fat-granules, and ultimately breaking down and in great part disappearing, so that what was once a considerable mass of cells may be represented by a few granules. This is most marked in scirrhus. In other cases the cells undergo colloid degeneration. A globule of colloid matter first appears in the cell, pushing the nucleus to one side. Finally the nucleus disappears, and the whole cell becomes filled with the colloid matter, and at last bursts. It is this change occurring in an encephaloid cancer that is supposed to give rise to the so-called colloid cancer. Creighton has lately described a process of vacuolation or endogenous cell-formation, to which he attributes the multiplication of the cells not only of cancer, but of sarcoma, and in his opinion the original cells of the cancer are formed from the pre-existing epithelium-cells of the part by this process. *The stroma* of cancer is in the vast majority of cases formed of fibrous tissue, throughout which we have cells, of the ordinary connective tissue type, scattered more or less abundantly. In rapidly growing cancers there may be numerous spindle-celled scattered amongst the fibres, or in some rare cases the whole stroma may be composed of spindle-cells, its structure then resembling that of a sarcoma. The alveolar arrangement is well marked in every scirrhous and encephaloid cancer; in epithelioma it is not so clear, but still the same type is maintained, that is to say, the cells are arranged in groups in immediate contact with each other, and the groups separated by fibrous or fibroid tissue, bearing vessels. The stroma of a cancer is often loaded with fat-granules in the degenerating parts of the tumor, but it very rarely undergoes calcification. It has been much disputed in former times whether the stroma of the cancer belongs to the tumor or merely represents the remnants of pre-existing tissues invaded by the tumor. There can be no doubt that the stroma is developed by an unnatural growth of the pre-existing connective tissues, just as much as the cells are supposed to be developed by an abnormal process of growth taking place in the pre-existing epithelium, but in no cancer is any structure which could be said to be a

mere remnant of the pre-existing tissues, ever found in the fully developed parts of the tumor. The stroma deviates as much as the cells from the normal structure of the affected part. The *blood-vessels* of cancer are very abundant, especially in encephaloid, in which the stroma may chiefly consist of vessels, the fibrous tissue being comparatively small in amount. The vessels frequently are so abundant as to give the whole tumor a distinct sense of pulsation. In some cases they show curious bud-like processes and dilatations projecting from their walls. That cancerous tumors are in intimate connection with the *lymphatics* of the parts in which they grow, no one can doubt, but the exact nature of this connection is not yet accurately made out. It has been asserted by Köster, of Würzburg, that the cancer cells actually lie in lymphatic spaces. Cornil and Ranvier state that there are abundant lymph-spaces opening directly into the alveolar spaces in which the cancer-cells are lying. Either view, if proved, would fully account for the extraordinary readiness with which cancer infects the system through the lymphatics.

Much diversity of opinion formerly existed among Surgeons as to the value that should be attached to these microscopic signs in determining the true nature of many tumors; some being guided by these appearances alone, others looking upon them as uncertain and fallacious, and trusting rather to the general characters of the growth. The latter, however, appears to me to be too limited a view of the subject; for, although the unaided eye of an experienced Surgeon may in many cases recognise the true character of a tumor, and the microscope in some few instances fail to afford much additional information, yet there can be no doubt that in most cases it is only by the aid of this instrument that the real nature of the growth can be absolutely determined.

It is doubtless true that every one of the microscopic elements above described may separately occur in the normal tissues and secretions of the body, some in the adult, others, as the caudate and fusiform corpuscles, in the embryo: but, though this be the case, it does not appear that they are ever found similarly grouped in any tumors, except those of a cancerous nature; and in these it is rather by the aggregation of these appearances, than by any single one in particular, that the true character of the disease is determined. In his examinations, however, the experienced Surgeon will find that the appearances presented to the naked eye will assist him much in pronouncing upon the malignant or cancerous character of the tumor.

Origin and Growth of Cancer.—The exact mode of origin and growth of a cancer is still a much disputed point, and opinions are still much divided upon it. Virchow attributed the origin and growth entirely to changes occurring in the connective-tissue-corpuscles. He believed that the first change was a multiplication of these cells, certain groups of which afterwards developed into cells of an epithelial type, while from the remainder the stroma was formed. This view may now be said to be finally abandoned, since the discovery of the exudation of the white corpuscles of the blood. There may then be said to be three chief views at present held by pathologists of high repute.

1st. That of Thiersch and Waldeyer, that the cells of cancer are the direct descendants of pre-existing epithelium cells, and that true carcinoma can never arise except in connection with epithelium. The term epithelium is here used in its limited sense, meaning only those cells which cover free surfaces, as distinguished from the "endothelium," which lines blood-vessels and lymph-spaces or cavities. On this view, true carcinoma can never arise primarily in bone, muscle, or subcuta-

neous tissue. Waldeyer believes that the rapidly-growing epithelium-cells force their way into the lymphatic spaces, and that the alveoli of the cancer-stroma are indeed only altered lymph-spaces. He believes he has demonstrated a layer of endothelium, covering the epithelium-cells of the cancer. If this be correct, the great readiness with which cancer infects the lymphatic glands is fully explained. The observations of Thiersch were confined to epithelioma; Waldeyer extended his views to all forms of cancer.

2nd. That of Köster, who also believes that the cells of a cancer are actually enclosed in lymph-spaces, but attributes their origin to prolifeeration of the endothelium of the lymphatics. On this view, true cancer may arise primarily in any structure of the body.

3rd. That of Classen, who attributes the growth of cancer to changes taking place in white blood-corpuscles, which have migrated from the blood-vessels. This view is identical with Virchow's, except that white blood-corpuscles are substituted for proliferated connective-tissue corpuscles—a change which has been almost universal in pathology since Cohnheim demonstrated the importance of the fact of the migration of these corpuscles. On this view also, true cancer may originate in any structure of the body.

The first of these three views is steadily gaining ground. It has the support of Billroth and many other eminent pathologists. This view necessitates the careful separation of malignant sarcomata, such as are common in bones, glands, and subcutaneous tissue, from true cancers, such as arise in connection with glands, skin, and mucous membrane.

Quite recently, Creighton has carried out a series of investigations for the Medical Department of the Privy Council, which tend to confirm the view that epithelium is the starting point of cancer; but he believes that under certain circumstances epithelium may also give rise to cells of the connective tissue type. The observations leading to this conclusion were made on a case of secondary spindle-celled sarcoma in the liver. He describes a process of vacuolation and endogenous cell-formation. A clear space first appears in the cell, pushing the nucleus to one side. In this space in the epithelium-cell, the spindle-cell is formed.

The question is necessarily one of great difficulty, and presents a large field for further inquiry.

Progress.—The general characters that attend the progress of the scirrhous and encephaloid forms of cancer present numerous points of resemblance. When once formed, the tumor continues progressively to increase in size, with a degree of rapidity, and to an extent, that vary according to its kind; the scirrhous tumor growing most slowly, and attaining but moderate dimensions; the encephaloid often with great rapidity, and to an immense size. When the full growth of the tumor has been attained, the process of decay commences. The mass softens at some point, the skin covering which becomes duskily inflamed and ulcerated, and an irregular sloughy aperture forms, through which the *débris* of the mass are eliminated in an ichorous or sanous fluid, having often a peculiar fetid smell. The ulcer then rather rapidly increases, with everted edges, a hard and knobby, or soft and fungating surface, and the discharge of a dark fluid, often attended by hæmorrhage, and occasionally with sloughing of portions of the mass. Coincidently with the implication and ulceration of the skin, there is usually deposit in the lymphatic glands with great increase of pain, and most commonly with the supervention of the constitutional cachexy; though in some cases this condition precedes the cutaneous implication. This cachexy

may possibly be due to some modification in the condition of the blood, induced by the action of the morbid growth on the economy. The exhaustion resulting from the ulceration, sloughing, and consecutive hæmorrhage, and the secondary deposits in internal organs, also commonly increases this cachectic state; in many instances it is not marked until after the skin has become affected, and in others it does not supervene until ulceration is actually set up. In this cachexy the countenance is peculiarly pale, drawn, and sallow, so that the patient has a very anxious and care-worn look. The general surface of the body commonly acquires an earthy or yellowish tint, and not unfrequently large spots of pityriasis or chloasma make their appearance on various parts of it; the appetite is impaired, the voice enfeebled, the muscular strength greatly diminished, and the pulse weak. The patient complains of pains in the limbs, of lassitude, and of inability for exertion; he emaciates rapidly, and frequently suffers by the occurrence of cancerous deposits in internal organs; and at last dies from exhaustion, induced by the conjoined effects of weakening discharges, general debility and pain.

These general characters of cancerous growths present certain important variations, according to the form of the disease that is developed.

Scirrhus.—The scirrhus, or *hard* cancer, is most commonly met with as a primary deposit in the female breast, in various portions of the alimentary canal, as the œsophagus, the pylorus, the sigmoid flexure of the colon, and the rectum, in the tongue, the penis, and the skin; secondarily, in the lymphatic glands. It occurs in two forms, either as a circumscribed mass, or infiltrated in the tissue of an organ. In either case it forms a hard, craggy, incompressible, and nodulated tumor, at first movable and unconnected with the skin, but soon acquiring deep-seated attachments, and implicating the integument. It grows slowly, seldom attaining a larger size than an orange. At times painless, at others it is painful aching generally, occasionally with much radiating and shooting pain through it. These sensations vary according to the part affected, and to the sensibility of the individual; the pains are especially severe after the tumor has been handled, and at night are of a lancinating, neuralgic character. The tumor may thus continue in a chronic state for a considerable length of time, slowly increasing, gradually extending its deeper prolongations, and implicating the more superficial parts. In some cases, more particularly in elderly people, scirrhus gives rise to atrophy of the organ in which it is seated, causing wrinkling and puckering of the surrounding skin, which becomes adherent to the tumor; and the cancer may thus continue in a very chronic state.

The ulceration usually takes place by the skin becoming adherent at one point to the tumor, either by dimpling in, being as it were drawn down towards it, or else by being pushed forwards, stretched, and implicated in one of its more prominent masses; it then becomes dusky and livid red, somewhat glazed, and covered by a fine vascular net-work. Softening occurs at one point, where a crack or fissure forms; a clear drop of gummy fluid exudes from this, and dries in a small scab upon the surface; this is followed by a somewhat bloody discharge of a thick and glutinous character; and the small patch of skin from which it issues, becoming undermined, speedily sloughs away, leaving a circular ulcer. This gradually enlarges, becoming ragged and sloughy, with craggy everted edges, having irregular masses arising from its surface, and discharging a fetid sanious pus. The pain increases greatly; and, the lymphatic glands becoming involved, cachexy is fully developed, and

the patient is destroyed by it or by the secondary visceral deposits. In old people, ulceration of scirrhous masses often assumes an extremely chronic character, the growth in them not being endued with the same vitality as in the young. The ulcer in these cases is flat, sloughy, of a greyish-green color, hard and rugged, with puckered edges, and much wrinkling of the surrounding skin, and exhaling the usual fetid odor. In younger persons, and especially in stout women with florid complexions, the disease usually makes rapid progress. So also, if inflammation be accidentally set up in the neighboring tissues, cancerous infiltration rapidly takes place in them. I once had under my care an old man with a cancerous tumor of the leg, which, after remaining stationary for seven years, became accidentally inflamed, and afterwards increased with great rapidity. Occasionally, but very rarely, scirrhous masses slough out, leaving a large ragged cavity, which may even cicatrise; and thus a spontaneous cure has been said to occur. The cancerous infiltration will extend to a considerable distance around the tumor into integument which to the naked eye appears quite healthy, but with the microscope will afford unequivocal evidence of the existence of cancer-germs diffused through it: it extends like a halo around the original tumor, and very probably shades off into the surrounding textures. It is of great importance in determining the question of operation to bear this in mind, and not to act on the supposition of the tumor being abruptly defined.

The secondary deposits from scirrhous tumors may take place in the viscera, more particularly the lungs or liver, or in the lymphatic glands; in the former situation they are often encephaloid, in the latter they assume the scirrhous form.

Structure.—After a scirrhous tumor has been removed, though still feeling firm under the fingers, it is not so hard as when it was in the body; owing, as Walsh observes, to the escape of its fluids and consequent loss of turgescence. On cutting it with the scalpel, it usually

Fig. 305.—Scirrhus of Breast (188 diam.). The communication of the alveolar spaces between one another and the continuity of the contained masses of cells is well shown. The contour of the individual cells is seldom definite, and the nucleoli, as a rule, are not seen.

creaks somewhat as it is divided, and presents a whitish or bluish-white glistening surface, intersected by white bands, which apparently consist partly of new structure, partly of included areolar tissue. This section has not inaptly been compared to the appearance presented by a cut

through a turnip or an unripe pear, hence termed *napiform* and *apinoid* by Walsh; and, from its reticulated character, *carcinoma reticulare* by Müller.

A curious feature about scirrhous cancer, in which it differs from almost all other tumors, is that it becomes cup-shaped on section. This seems to be due to the fact that in the most scirrhous tumors a kind of process of cicatrisation takes place in the central parts, while the peripheral parts are still growing. The cells undergo fatty degeneration and break up. The greater part of the products of degeneration are absorbed, and only a narrow streak of granules may be left to represent a once large accumulation of cells. It is this shrinking of the growth that drags in the nipple in scirrhus of the breast, and perhaps it is the evident state of tension in which the tumor is, that gives rise to the peculiar pain of scirrhus in general. On examining a scirrhous cancer microscopically (Figs. 305, 306), it will be found to be surrounded everywhere by a zone of small round cells infiltrating the surrounding parts, penetrating between fat-cells and muscular fibres, and extending along bands of connective tissue. A little nearer the centre the alveolar arrangement becomes apparent, and groups of rounded or irregular cells, with large oval nuclei, are found imbedded in spaces in a stroma of coarse fibrous tissue. These spaces communicate with each other like those of a sponge. The stroma and cells there usually form about equal bulks of the growth. The stroma shows signs of active growth, having spindle-cells scattered here and there through it, sometimes in abundance. A little nearer the centre we find the cells beginning to degenerate, the nuclei becoming hidden by clouds of fat-granules, and perhaps fat granules appearing in the stroma; the spindle-cells are replaced by elongated tailed cells with scarcely any protoplasm around the nuclei. Towards the centre the fatty cells disappear, and a few granules only mark where they were, and the stroma becomes dense and hard, and even the nuclei before mentioned are difficult to recognise. The above is a description of the ordinary scirrhus of moderately slow growth. In more vigorously growing specimens the degeneration is delayed, the cicatrisation is less perfect, and the proportion of bulk occupied by the cells is increased.

Fig. 306.—Scirrhus of Breast (188 diam.). Much cicatrised; the stroma bears a large proportion to the cells, which are small and granular; in a fully cicatrised specimen there would be similar alveolar spaces containing only granular débris.

Encephaloid.—A large number of growths formerly classed as encephaloid cancer are now included under the various forms of rapidly growing soft sarcomata. The true encephaloid cancer is a comparatively uncommon disease. It occurs in the testis and the breast, and may often attain an enormous size, equal to that of an adult head. In bone it is extremely rare, if it ever arise in this situation primarily. The tumors formerly described as cancer of bone are now included under the names

of round-celled, spindle-celled, and giant-celled, or myeloid sarcoma. The encephaloid cancer of the eyeball is now classed with sarcomata, under the name of glioma or glio-sarcoma; and the disease described as cancer of the bones of the face is now also known to be almost invariably, if not always, sarcomatous.

Encephaloid cancer commences as a tumor, which, though occasionally somewhat hard, is usually from the first, or at all events soon becomes, soft and elastic, being more or less lobulated, growing rapidly, and having an elastic and at last a semi-fluctuating feel. The skin covering it is usually at first pale and loose, with a large net-work of dilated veins spreading over it. In some cases, however, at a very early period, a species of inflammatory œdema occurs in the integuments covering rapidly growing encephaloid tumors. As the tumor enlarges, the skin becomes adherent, discolored, of a purple-brown tint, and at last ulcerates at one point. When once the tumor has made its way through, and is relieved from the pressure of the fascia and integuments, the rapidity of its growth becomes fearfully increased; and a large soft fungous mass, rugged, irregular, dark-colored, and bleeding profusely, rapidly sprouts forth, constituting the affection to which Hey gave the appropriate term of *fungus hæmatodes:* when this condition has been reached, death rapidly ensues from exhaustion and hemorrhage. Pulsation has been met with in particular forms of very vascular encephaloid; in these cases also a loud bruit, synchronous with the pulsation and the heart's action, has been detected, and may be heard on the application of a stethoscope. These symptoms have been most frequently met with in encephaloid tumors connected with bone, and may, unless care be taken, cause the disease to be confounded with aneurism.

The constitutional cachexy in encephaloid occurs early, and is well marked; and secondary affections of the lymphatic glands and viscera, occasionally of a scirrhous character, often take place.

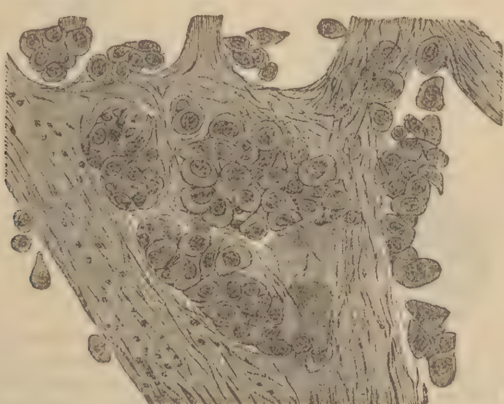


Fig. 307.—Encephaloid of Breast (158 diam.). The large-celled variety. Attention is directed to the much larger spaces in this than in Scirrhus.

No absolute and sharp line can be drawn between scirrhus and encephaloid; they gradually merge into one another. Thus the secondary tumors in the liver are usually somewhat firm, and often go by the name of scirrho-encephaloid. Again, a tumor which one Surgeon might call encephaloid of the breast, another might speak of as a rapidly growing scirrhus.

Structure.—After removal, the tumor is found to be very vascular, displaying on injection a close net-work of vessels. On a section being made, it commonly presents a soft pulpy white mass, closely resembling cerebral substance, stained and blotched with bloody patches, varying in color from a bright red to a maroon-brown, this being dependent on blood that has been infiltrated into its substance. In other cases, its section has been compared to that of a raw potato, or a piece of boiled udder. On microscopic examination, it will be found to present a structure essentially similar to that of scirrhus, that is to say, an alveolar stroma enclosing groups of free cells of an epithelial type. The cells may in some cases be larger, but are often smaller than those usually seen in scirrhus (Fig. 307). They assume the same irregular forms, and have each one or more highly refracting nuclei and nucleoli. The proportion of the bulk of the tumor composed of cells is, however, infinitely greater in encephaloid than in scirrhus, and the vascularity of the tumor is proportionately increased. The tumor does not show the same tendency to cicatricial contraction, although fatty degeneration always occurs in the central parts.

Other Varieties of Cancer.—Special names have been given to varieties of cancer, dependent merely on peculiarities of appearance or structure. Two only of these, the *Colloid* and the *Melanotic*, require notice in this place.

Colloid, Gelatinous, or **Alveolar Cancer** may occur in distinct masses, often of a very large size, weighing many pounds, or may be infiltrated into the tissue of organs. As it is most commonly met with in the viscera of the abdomen, it does not so often fall under the observation of the Surgeon as the other varieties of cancer. Yet it may form superficially. I have met with it in the breast, forming a very large tumor; and there is a preparation in the University College Museum of

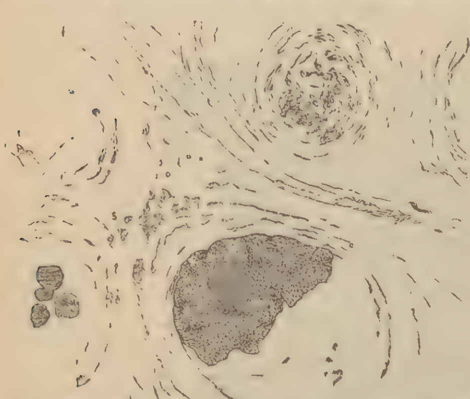


Fig. 308.—Colloid of Omentum (188 diam.). Shows the concentric rings and the granular masses which have taken the place of the cells; and at one part a few cells still retain their shape.

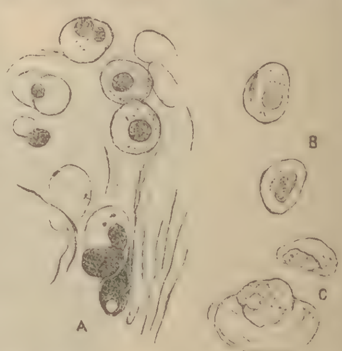


Fig. 309.—A. Colloid of Breast. Shows relation of cells to stroma, and the colloid material in some cases filling the cell, in others pushing the nucleus to one side or completely surrounding it. B. Isolated cells from the same tumor. C. Isolated cells from colloid of omentum. (454 diam.)

a scirrhous breast containing colloid. Colloid cancer consists of alveolar spaces of great size, filled with a clear semi-transparent yellowish gelatinous or honey-like material, resembling indeed somewhat the structure of a honey-comb. The septa forming these spaces are distinctly

fibrous and regular in their arrangement (Fig. 308). Some of the spaces are completely filled with colloid matter, others may show a few cells containing fat granules in the centre, surrounded by zones of granules, resulting from the degeneration of other cells. Cells again may be seen in the process of undergoing colloid degeneration. A globule of colloid matter first appears pushing the nucleus to one side; afterwards the nucleus undergoes a similar degeneration; and finally the cell bursts and disappears, leaving behind it only a few granules (Fig. 308). True colloid cancer is merely a degeneration of scirrhus or encephaloid. Many other tumors have been described in former times as colloid, amongst which may be mentioned many myxomata, œdematous soft fibromata, and some glandular tumors which had undergone colloid degeneration.

Melanotic Cancer.—It is quite possible that there may be a pigmented form of true cancer, but if so it is extremely rare. Such a form of tumor is mentioned by Cornil and Ranvier, but they do not record a case. The tumors formerly described under the name of melanotic cancer have already been mentioned with the sarcomata (see page 752). So-called *Osteoid Cancer* is probably always ossifying sarcoma.

Diagnosis.—The diagnosis of the different forms of cancer is not always easily made. *Scirrhus*, when in tumor, may very readily be confounded with fibrous tumors and chronic glandular masses, or with the indurated atrophy of a part; in many of these cases, indeed, the diagnosis cannot be correctly effected until after removal. In other cases, however, the rugged feel, the lancinating pains, and the tendency to the implication of the lymphatics, or to affection of the general health, will commonly serve to establish the diagnosis. When ulceration has taken place, the previous condition of the tumor, the general character of the sore, and the microscopic examination of the *débris*, may serve to denote its true character.

Encephaloid in tumor may be confounded with abscess, with cysts, or with fatty, erectile, and sanguineous tumors, and with the various soft varieties of sarcoma; and, when pulsating, with aneurism. In these cases careful palpation, the existence of elasticity without fluctuation, and the presence of the large and tortuous veins ramifying over the surface of the mass, may establish its true character. When it is fungating, it may be confounded with the sprouting intracystic growths that sometimes spring from the interior of a cystic tumor. Here, however, a microscopic examination of the *débris*, as well as the existence or absence of contamination of neighboring lymphatics, will show the true nature of the affection.

The diagnosis of a tumor as a cancer is sometimes materially obscured by the accidental development of abscess in the tissues around or above it. In such cases, the continuance of a swelling which is evidently not inflammatory, after the pus has been evacuated, may lead to a suspicion as to the true nature of the disease.

Causes.—The causes of cancer, as of all other diseases, may be divided into two great classes, viz.: the constitutional or predisposing, and the local or exciting.

So far as the constitutional or predisposing causes of this disease are concerned, it may be said that it is difficult to connect any distinct or recognisable constitutional condition with a tendency to this disease. Cancer no doubt commonly shows itself in persons apparently in perfect health, of florid complexion, robust habit of body, with every aspect of health and sign of strength.

But if we fail to recognise by outward signs a constitutional tendency

to cancer, we cannot doubt that its development is connected with a hereditary tendency, and is influenced by age.

The *hereditariness* of cancer has been established beyond a doubt. Velpeau states, as the result of his researches, that it is traceable hereditarily in one-third of the cases. Paget finds that amongst hospital patients the hereditariness amounts to about 1 in 6, but amongst private patients, whose family histories are better known, it is found to be hereditary in 1 in 3; thus agreeing with Velpeau's estimate.

In this respect cancer stands very much in the same category as many other tumors, and, as will be shown more fully when we come to discuss the complicated and very difficult question of the origin of cancer, hereditariness must not be taken as synonymous with the constitutionalism of cancer or any other disease.

A strictly local tendency, whether to shape of feature, deformity of body, or purely local tumor, as wart, ganglion, or lipoma, may be transmitted as readily as a constitutional predisposition to any given disease. Hence, in saying that cancer is hereditary in one-third of the cases, it is not necessarily implied that it is constitutional in them, but simply that there is a tendency in a certain number of individuals to transmit the disposition to the disease to their offspring, just as they may transmit a peculiarity of feature, a tendency to premature baldness, or to a fatty tumor. Admitting the hereditary nature of cancer to the fullest extent, however, it still leaves two-thirds of the cases unaccounted for.

Age exercises a marked influence on the occurrence of cancer; and its influence is marked in two ways:—1. In the absolute frequency of the occurrence of cancer; and 2, in the relative frequency with which it develops in different organs at different periods of life, and in the different forms that it assumes.

Although cancer is undoubtedly rare in early life, yet it may possibly be a congenital affection. It may occur at all periods of life from the earliest ages; and it will evince itself in persons from eighty to ninety years of age. According to Walshe, the mortality from cancer goes on steadily increasing until the eightieth year; hence the popular belief, that the middle period of life is most obnoxious to it, would appear to be an erroneous one. Age, however, influences the liability to cancer in special organs. Thus malignant tumor of the eye and of the bones frequently occurs in children; of the testis, not uncommonly, in young adults; whilst, in the female, Sidney states that the average age of patients with uterine cancer is forty-three, and with mammary, forty-eight years. All forms of cancer are not, however, met with in equal frequency at all ages; the encephaloid being the most common in the young, and scirrhus in the middle-aged and elderly. The colloid variety rarely occurs before the age of thirty.[1]

Mental Emotions of a depressing character, if long-continued or frequently repeated, may possibly predispose to the occurrence of cancer. I have seen so many cases of cancer, more particularly of the abdominal organs, in individuals who have suffered much from grief, anxiety, or harass of mind for years before the development of the malignant disease, that, although the doctrine is incapable of proof, I cannot but look

[1] The statistics of cancer require complete revision. No reliance can be placed on those which were made before pathologists had learnt to separate rapidly-growing sarcomata from true cancers. These tumors were up to a very recent period commonly mistaken for encephaloid—just as hard sarcomata were for scirrhus. The older statistics are correct as applying to tumors generally which run a malignant course, but certainly not to cancers.

upon it as probable, that the cancer was the result of the antecedent long-continued mental disquietude. We know, by every-day experience, that functional derangement of the abdominal and pelvic organs of the most inveterate character may be occasioned by mental disturbance; and it appears to me not improbable, that such functional derangement may at last lead to perversion of nutrition, terminating in malignant deposits in such organs as the uterus, the liver, or the stomach, as are more readily influenced by the condition of the patient's mind.

Sex.—The influence of sex is well marked, not only in the absolute frequency of cancer, but in its occurrence in organs that are special to each sex. Cancer is absolutely far more frequently met with in women than in men, simply because cancers of the uterus and mamma constitute by far the largest proportion of these diseases, being infinitely more common than cancers of the male organs. But when we come to cancers of organs that are common to both sexes, as the eye, the tongue, the lip, the intestinal tract, &c., we shall, I think, find that they are more common in these situations in men than in women; the difference, however, not being sufficient to counterbalance the preponderance in the female reproductive organs.

The *Exciting* causes of cancer are of two kinds; direct external violence, or long-continued irritation of a part.

A blow on, or other injury of a part, often appears to be the direct determining cause of the development of a primary cancer. Scirrhus of the mamma is commonly attributed by the sufferer to the infliction of an injury. So in other situations. Thus Paget relates cases in which cancer has developed after the fracture of a bone at the seat of injury, and in the orbit after a blow on the eye.

Long-continued irritation of a part may also develop cancer. This is a matter of every-day observation in the development of cancer of the tongue from the persistent irritation of a broken or jagged tooth, or the production of cancer of the lip by the constant use of an unprotected clay-pipe. But, perhaps, the best marked instance of the production of this form of cancer, is that of the cancer of the scrotum in chimney-sweeps, developed by the irritation of the soot lodged in the rugæ—a form of disease which, as De Morgan has pointed out, is fast disappearing with the cessation of the employment of climbing-boys, a strong argument in favor of the theory of the local origin of cancer, that a form of the disease should cease to appear on the removal of the source of local irritation that produced it.

But local irritation is more likely to produce cancer if it be applied to a part that has already been for some time the seat of structural epithelial change. Thus a common wart, mole, or cicatrix is very apt to assume a cancerous action under the influence of persistent irritation. And, as J. Hutchinson has truly observed, a cancer may in this way be "grown."

The mode in which a local injury or source of irritation produces a cancer is unknown. Does it do so by some peculiarity of local action, or by a constitutional state of a cancerous nature causing what might otherwise prove to be a simple irritation to assume a malignant form? The answer to these questions involves the whole theory of the local or constitutional origin of cancer, to which I must refer the reader. (See page 769.)

It is very important to bear in mind that all tissues and organs are not equally liable to cancer. Amongst the tissues, the skin and mucous membrane and the parenchyma of organs are the favored seats of the

disease. It is a doubt whether it ever occurs primarily in serous or synovial membrane, muscle, or cartilage.

Every organ of the body is liable to the development of cancer. But it occurs most frequently in the organs of reproduction—in the mamma and uterus of the female—in the penis and testis of the male. The tongue and certain portions of the intestinal tract—viz., the cardiac and pyloric orifices, the sigmoid flexure, and the lower part of the rectum and the anus—are favorite seats for the development of cancer. It has been observed that in those organs which have intermittent functional activity, cancer is more frequent than in others, and in them it is especially apt to occur at the periods of commencing senile degeneracy or functional disease.

The Geographical Distribution of Cancer is a most interesting and important element in the problem of its origin, and by a closer study of it than has hitherto been made, I believe that much light may be thrown on this.

Cancer appears to be a disease favored by, if not actually dependent on, the aggregation of individuals under the influence of an advanced civilisation. Amongst savage tribes, as amongst wild animals, it is unknown. In the great centres of civilisation, as amongst domesticated animals, it abounds. This circumstance points certainly to the possibility of there being a parasitic origin for the disease—to the possibility, in fact, of its being originally an organism that has entered the body from without. Of this, however, we possess as yet no evidence.

Cancer is said to be unknown in the frigid zone. The Esquimaux in the Western, and the Samoieds and other migratory tribes in the Eastern hemisphere, are equally exempt from it. Amongst the inhabitants of the torrid zone it also rarely occurs; though in the more populous parts and the seats of an older civilization, as in India, it is not unknown. But on this and other points connected with the geographical distribution of this fell scourge, we require additional and precise information.

Cancer is certainly more common in Europe than in any other part of the civilised world. In some parts of the United States of America and in China it also appears to be of frequent occurrence, whilst in South America, in Africa (except Egypt), and in the greater part of Asia, it is not common.

Haviland has obtained very important results from the investigations of the tables of mortality of this country, with regard to the distribution of cancer in Great Britain; and his investigations appear to lead to this conclusion, that geological formation, soil and resulting endemic conditions exercise a marked influence on the development of cancer.

Haviland finds, with regard to England, that cancer is most common in the western and north-western parts of the kingdom, including Wales; and that generally throughout the more elevated midland and southern districts it is not common. It is less frequent on the older geological formations, towards the sources of rivers, and in dry well-drained districts. He points out, on the other hand, that the sites of the great cancer-fields of England are the tertiary formations and the alluvial districts; that cancer surrounds the course of the great rivers after their full formation, when they are passing through valleys and low-lying lands liable to floods and to the consequent accumulation of alluvial deposits. These districts are also the most densely populated. Hence it may be inferred that density of population favors the production of cancer, and that wherever social organisation is highly developed, there cancer becomes proportionately rife. But this view is not quite borne out by

statistics. Thus we find that the development of cancer does not depend on mere population, as the mortality from cancer in Norwich and Great Yarmouth, comparatively small towns, is to that in such great centres of population as Liverpool and Manchester as 141 to 84, or nearly double; that in Philadelphia it is to that in the much larger city of New York as 15 to 7, or more than double; while in Marleybone it is very far higher than in the capital of Pennsylvania. In these conclusions we must not, however, omit to take into account the increased tendency to hereditary transmission amongst a comparatively settled population, such as that of the east of England.

Is Cancer a Disease of Constitutional or of Local Origin? This question has led to much discussion among pathologists. There are at least three distinct theories with regard to the origin of cancer. *a.* It is a blood-disease *b.* It is purely local in its origin. *c.* If local in its origin, it can only be developed in a constitution that is fitted in some way for its formation; a fitting soil, in fact, is required for the cancer to germinate in.

We will consider these views separately; and in so doing, I may observe that it will be extremely difficult, if not impossible, to separate the two questions as to the origin and the development of cancer from one another; for, however essentially they may be distinct and separate, they blend themselves in such a discussion as this in an almost inextricable manner.

a. That cancer is a blood-disease—a disease essentially dependent on a morbid state of the blood, is a view that has long been entertained by many. But in truth, this doctrine with regard to the origin of cancer has been made to include two distinct propositions; the first being, that the blood itself is charged with the poison of cancer which is ready to burst forth or to sprout out on any part of the body on the application of the necessary local irritation or disturbance. The second view is that "blood-disease" and a "constitutional disease" are synonymous and convertible terms. This is undoubtedly an error. It is quite possible to understand and to hold the view that the tissues of the frame are imbued with a cancerous tendency, without having recourse to the hypothesis that they derive this from the blood. The germinal membrane of the chick, as has been pointed out by Sir W. Gull, takes on changes antecedently to, and independent of the formation of the blood. And so we may take it as possible that the tissues of the body may inherently possess morbid or cancerous proclivities, independently of the blood by which they are nourished. But if by blood-disease, be meant a disease in which the blood actually contains the cancer-cell, as the blood in gout does the materies morbi of that disease—*viz.*, uric acid circulating through the body and capable of deposit in some locality favorable to the local development of the malady—this hypothesis is certainly untenable. There is no evidence whatever, histologically, that the blood of any individual is a poison-bearing fluid, and has a cancerous constitution or tendency, or that, at all events before the primary growth has developed itself, the cancer-cell, or any material capable of undergoing cancerous development, is met with in the blood. Every phenomenon that occurs in connection with cancer may be explained without having recourse to such a hypothesis as this, which has not a particle of pathological observation on which it can be based. But if the doctrine of cancer being a blood-disease is untenable in the sense in which I have here stated it, the same cannot at once be said in the way of its being primarily a constitutional affection independently of the blood.

The doctrine of the constitutional origin of cancer may be more clearly expressed in the words of Paget. "Cancers are manifestations of certain specific and morbid states of the blood; and in them are incorporated peculiar morbid materials which accumulate in the blood, and which their growth may tend to increase." "The existence of the morbid material in the blood, whether in the rudimental or in the effective state, constitutes the general predisposition to cancer; it is that which is by some called the predisposing cause of cancer. The morbid material is the essential constituent of the cancerous diathesis or constitution; and when its existence produces some manifest impairment of the general health, independently of the cancerous growth, it makes the primary cancerous cachexia." For the local manifestation of this constitutional disease, the part where it is developed must be put into a favorable condition by irritation, injury, or other similar cause. The blood-disease and the local conditions may compensate each other; thus, with an intense cancerous diathesis, tumors may be formed in such a way and in such numbers as to be apparently independent of local conditions; while in cases where the constitutional element exists in a low degree, a long continuance of irritation may be required to bring out its local manifestations. Paget believes that by this theory of compensation the opposing views as to the local or constitutional origin of cancer may be reconciled.

b. The theory as to the local origin of cancer appears to be more generally adopted by Surgeons. Velpeau, Virchow, De Morgan, all support or incline towards it. The arguments on which it is based may briefly be summed up as follows. They are certainly sufficient to account for all the phenomena of cancer; and many of these phenomena do not admit of explanation on any other theory.

1. Cancerous tumors spring up in individuals who have always enjoyed perfect health, and who are to all appearances perfectly well at the time of the occurrence of the disease. As in these cases there is no evidence whatever of constitutional affection of any kind, it would be a begging of the whole question to assert that the existence of the local tumor must of itself be taken as an indication of a constitutional cancerous tendency.

2. Such primary tumors are always single—no primary outbreak of multiple cancers ever occurs. Tumors may form in certain cases in rapid succession, but never simultaneously. But primary cancer does not occur at the same time at different of these seats of election—as the mamma, pylorus, and rectum, as would be the case were it constitutional.

3. Cancers are not unfrequently the result of some local injury or irritation. This is a matter of daily observation in the lip, the tongue, the female breast, &c.

4. The primary tumor only attacks certain organs which are the seats of irregular functional activity, as organs of generation, or certain parts of other organs, as of intestinal tubes.

5. The constitutional health does not, in the majority of cases, suffer until some months have elapsed; when, after the lymphatics or glands have become implicated, or the neighboring tissues invaded, but not until then, signs of cachexy set in. In many cases of cancer, especially of the mamma, the health continues excellent for many months—a year or two even after the disease has declared itself, and so long as it continues to be confined to its primary seat. It is not until after secondary deposits have occurred that the characteristic cachexy set in.

6. If the primary tumor be removed before neighboring parts have

become contaminated, the health, if it have suffered, often improves materially.

7. Primary cancer becomes secondary or constitutional—α. By extension by continuity of tissue to neighboring parts adjacent to primary disease; β. Through lymphatics; and γ. Through blood leading to deposits in internal organs.

8. Secondary cancers affect the form of the primary one. Thus, primary encephaloid leads to deposit of encephaloid masses in the lungs; scirrhus of the rectum to secondary scirrhus of the liver, with identical structural peculiarities.

9. Growth is favored by local circumstances, as warmth and moisture of cavities.

10. In some rare instances no recurrence whatever takes place after operation, the disease being eradicated from the system, which could not be the case if it were constitutional. In the majority of cases, the patient remains free from recurrence of the disease for many months, or even years.

11. When recurrence does take place soon after an operation, it is almost invariably either in the cicatrix or its immediate neighborhood, owing to cancer-cells which had been widely infiltrated, or had migrated, escaping removal, and subsequently developing into new tumors. Were the disease constitutional, recurrence would be as likely to take place in other parts, especially in symmetrical parts, or as it does when the operation has been too long delayed in internal organs.

12. We observe the same tendency to recurrence after removal, and even to secondary deposit in distant organs, in other tumors which are incontestably primarily local, such as the sarcomata and the enchondromata, and which only become general in certain constitutions under special conditions in their more advanced stages, and in a secondary manner.

The theory of the local origin of cancer is undoubtedly a very captivating one. It explains in the readiest and the simplest way possible most of the phenomena of the disease. But it is a doubt with many, if it be competent to give a satisfactory solution of all.

There are at least four conditions that may be supposed to militate against the theory of the primary localisation of cancer, and which have been, or may be, adduced as evidences of the constitutional origin of the disease.

These are—1. The almost absolute certainty of the speedy recurrence of the disease after the removal of the primary growth;

2. The frequent hereditariness of the disease;

3. The varying degrees of rapidity with which cancers run their course and the different degrees of virulence they affect in different individuals; and

4. The geographical distribution of cancer.

Let us briefly examine those conditions, which have mainly been relied on in support of its constitutional origin.

1. As to the *liability to recurrence after removal*, as will be more fully stated when we come to speak of the operation for cancer, there can be no doubt. But in truth this argument can have but little weight, when we consider the rapid tendency to diffusion that has just been described as characterising cancers above all other tumors, owing to the absence of an enveloping capsule. The fact is, that the cancer-cells have already become diffused through the neighboring structures, and they or the cancer-juice may have entered the lymphatics or the blood long

before the primary tumor has attained such a size as to attract attention or to render operation possible.

If it be admitted that a cancer may commence this process of diffusion, of self-multiplication, at any period after its first formation as a distinct tumor or growth, it is impossible to deny that the recurrence of the disease after operation, whether local in the neighboring areolar tissue, more distant in the lymphatic glands, or, further still in the viscera, may be due to the early spread of migratory cells, each of which has become the centre of a new recurrent growth. It would be too late to uproot the oak after the acorns had been widely scattered abroad.

One main source of confusion, if not of error, in respect to the origin of cancer has been, that it has usually been studied in organs, such as the mamma, in which its early origin cannot be discovered. In such a situation a tumor must attain the size of a nut, at the least, before it is diagnosed or even detected. How many months, or even years, may it have required for the first cell—not a 1,000th of an inch in diameter—to have led to the development of such a mass as this, and how widely the local contamination and general infection may have spread, before such a size even as this is attained by the primary tumor.

The rapidity with which a purely local condition may infect the constitution is well illustrated in the case of a chancre. If once an indurated chancre has formed, the removal of the sore by excision would not save the patient from constitutional contamination, which begins to take place almost from the very first moment of the formation of the true chancre. The same is probably the case with a cancer, which, when once formed, then immediately commences the infecting process. In fact, the analogy between the two diseases is perfect.

2. The next point is as to the *hereditariness* of cancer. As has already been stated, this is undoubted. But an hereditary tendency to a disease must not be confounded with a constitutional disposition to it. It is a fatal error in etiology to confound hereditariness with constitutionalism. Hereditariness may be local as well as constitutional. The hereditary transmission of a particular feature from parent to offspring cannot be considered a proof of a constitutional tendency. So also the hereditary transmission of a malformation, as of supernumerary fingers or exostoses, is certainly purely local. But diseases may also be transmitted through descent without being in any way constitutional. Tumors that are not cancers are hereditary, as ganglions, warts, lipomata, enchondromata, etc.; sebaceous cysts of the scalp are strongly hereditary, and yet there can be no pretence that these are in any way constitutional or blood-diseases. These are instances of hereditary local diseases that are not congenital, but develop after the body has reached maturity; just, indeed, as a cancer does. We do not look upon these conditions as constitutional—dependent on some conditions of the blood, merely because they are transmitted from parent to offspring. All that we can at present assume is, that it is probable that in some cases there is a predisposition of unknown nature, hereditarily transmissible, which may tend to the development of cancer without the action of a known local exciting cause; and this hereditary tendency may be local, as in a certain tissue, or in a particular organ which is the usual seat of election of cancer, as the mamma, the testis, or the pylorus.

3. The *greater virulence* affected by cancers in some individuals than in others, and the *varying degrees of rapidity* with which they run their course, would undoubtedly lead to one of two inferences; either that the

primary cancer is more active, has greater inherent vitality, or that the constitution in which it occurs is more favorable to its development.

That some cancers are inherently and *ab initio* more active, more virulent in fact than others, independently of the constitution of the individual, is evident from the greater rapidity and virulence with which some recurrent cancers will develop themselves than did the parent growth.

But that some constitutions may be more favorable to the development of cancer, may be a more fertile field for the primary local growth than others, there is every reason to believe. We see this in syphilis and tubercle. We know that there are individuals in whose constitution, when once syphilis has become engrafted, the disease assumes the most virulent and intractable form. The danger in fact of contracting a chancre varies very greatly in different individuals—not owing to any difference in the primary disease, but in the soil on which it is implanted. So it is with tubercle. This product is not known to be in many cases at least local in its origin. But it requires a fitting soil—a "tuberculous" constitution—in which to germinate.

So it is also with the parasites that infest the human body. That all individuals are not equally fitted to be their *habitat*, there can be no doubt. The conditions under which ascarides, lumbrici, or skin-parasites will originate and develop, do not equally exist in all. These parasites are undoubtedly local in their formation—a fitting soil for their growth existing in some, not in others. They are not the "local manifestations of a constitutional vice," but simply of a morbid local state in those constitutions in which they find the necessary elements for their development.

So it is with cancer. There is a tendency in the tissues of certain individuals to favor the development of these cancer-growths, originating primarily in some local irritation, whether this be traumatic or functional. Such a constitutional state, whether congenital, hereditary, or acquired, is necessary to constitute a fitting soil for the cancerous element, in which to form and to develop. The stronger the tendency the more readily will cancer grow in such individuals, and the more rapid and vigorous will be the growth. The constitutional state does not develop a local cancer; it simply favors its development by allowing local irritations of various kinds, which would be incapable of producing it in perfectly sound constitutions, to give rise to that one primary cancer-cell which forms the starting point of every tumor, and by affording it a fitting nidus of development.

4. The *geographical distribution* of cancer has already been considered at p. 768. The peculiarities in this respect undoubtedly cut both ways—in favor of its local as well as of its constitutional origin. For it may fairly be argued that the influences resulting from soil, climate, &c., may develop a local parasitic growth, or that they may give rise to constitutional states developing a cancer.

On reviewing the whole of this intricate question, I think we may fairly conclude that—1, cancer is primarily a disease of local origin; 2, it is often occasioned by the direct action of local causes; 3, it is predisposed to by various local conditions, physiological as well as anatomical; 4, like all other local diseases, it is under the influence of age, sex, habit of body, and hereditary constitution; 5, and although once originating locally its development is favored by constitutional conditions; 6, there is no evidence of the existence of any constitutional

state that can primarily, *per se*, and independently of any local cause, functional or organic, develop a cancer.

There are two points in connection with the structure of cancer that deserve careful study, in reference to the question of local origin. The first is the abundant blood-supply that a cancerous tumor invariably demands and obtains; the second is its want of a limiting capsule.

The first of these points has an important bearing on its growth, the second on its diffusion.

1. The much larger *blood-supply* that is furnished to a cancerous growth than is sent to any other kind of tumor is well known to all practical Surgeons. A scirrhus of the mamma, not larger than a pigeon's egg, will receive a far larger vascular supply than an adenoma as large as a cocoa-nut, the number of arteries requiring ligature after operation in one case being greatly in excess of those that sprout in the other. This abundant vascular supply is noticeable in the removal of the smallest cancers, but increases with the size of the tumor.

The tumor itself is not usually vascular, though some cancers, as the encephaloid, are so abundantly so as to present little else than a congeries of vessels, and to possess active pulsation and bruit; but the vascularisation is in the neighboring and surrounding parts, in the midst of which it lies. It is always arterial in the deeper parts, the corresponding venous enlargement being usually superficial. Now this is different from what we see in any local manifestations of constitutional disease. In syphilitic gummata or tuberculosis, we see nothing like it.

Now to what is this increased vascularisation of the neighboring tissues due? It must be to one of two causes—either to the local irritation produced by the tumor, or to the supply required for the sustenance of an organism having an active growth inherent in its nature. That the increased vascularisation cannot be due to mere local irritation of a heterologous or foreign mass embedded in the tissues, is probable from the fact that the local irritation excited by the mere presence of such a tumor would be equally great in others, such as lipomata, enchondromata, exostoses, &c., in which it is certainly not observed. It must therefore be due to the second of these causes, viz., the demand made by an independent organism having an inherent active vitality, capable of self-support, yet drawing its nourishment from the parts amongst which it lies imbedded; and certainly this active arterial supply, this great afflux of blood evidently required by the tumor for its nutrition and development, and supplied by an active hyperæmia of the neighboring parts, is scarcely compatible with the idea of cancer being an evidence of senile degeneracy of organs or their tissues, but rather that it is an active independent organism, full of the vigor of an independent existence, and requiring a free afflux of blood for its nutritive growth and highly complicated development. It is, I think, viewed from this point, a strong additional argument in favor of the primary local origination of cancer.

2. The second important point in connection with the structure of a cancerous tumor is the *absence of an enveloping capsule;* unlike almost every other tumor, it is not in any way encysted or encapsuled. There is consequently no barriers between it and the tissues in which it is deposited; nothing to limit its extension into and its absorption of and conversion into its own structure of the contiguous tissues.

The very smallest scirrhous tumor—one not larger than a pin's head—that can be picked out of the scattered tubercles that will sometimes disseminate themselves through the skin in the neighborhood of a scir-

rhous mass, is as destitute of a capsule or of any kind of limiting envelope around it, or of barrier thrown out by the neighboring tissue, as is the largest cancer. So, doubtless, would be such a tumor from the very first hour of its formation, whilst yet invisible to the naked eye, and only a minute microscopical body implanted on the tissues. And yet, from the very first moment that a cancer exists as such, it must be presumed to consist of those three elements that conjointly enter into the formation of all cancers, and that constitute, not singly, but by their combination, a cancer, viz., cell, stroma, and cancer-juice.

What circumstances or conjunction of circumstances can possibly favor more highly the diffusion throughout the neighboring tissues and of the whole system of a primary growth thus constituted, stimulated to rapid growth by an active arterial supply, than the want of a capsule?

This absence of capsule may lead to a much earlier contamination of tissues and of constitution than is generally supposed. We know well, because we have evidence easy of verification, how early after its formation a chancre will infect not only neighboring lymphatics, but will contaminate the whole system with its specific virus. But we do not know, and there is in the present state of science no possibility of ascertaining, how soon after its first formation, whilst still a microscopical nodule, a cancerous tumor may begin to shed its wandering cells into neighboring areolar spaces, to diffuse or transude its juice into contiguous lymphatics. From the very first day of its formation—from the very first of the multiplication of its cells—that highly organized but fatal migrating cell may have started on its travels into areolar spaces, carried on by amœboid movements, but capable of self-support whenever arrested, there developing by an inherent and active vitality of its own; exciting the neighboring arteries to furnish it with an ever increasing vascularity, and in its new *habitat* developing into a fresh cancerous centre, capable in its turn of the same process of multiplication and of local infection, which may be indefinitely extended; capable also, probably, of entry into the vessels, of being carried through them to distant organs, and deposited in them, like pyæmic embola, forming centres of arrest and of deposit, and of multiple and new growths in the lungs or liver.

It is this early and rapid tendency to the dissemination of cancer consequent upon the want of an enveloping capsule, that leads to the supposition of its being constitutional. For the system may become permeated by cells shed from the parent primary tumor, before this has attained sufficient size to attract serious attention, if indeed, it has been observed at all.

But cases frequently occur in which cancer can be distinctly traced to some local cause, being immediately occasioned by a blow, injury, or other violence, or by a long-continued irritation of the part that eventually becomes affected. Thus a blow on a woman's breast may give rise to cancer of the mamma; and the irritation of a broken tooth may occasion it in the tongue. It is disputed whether external causes of this kind can give rise to the production of cancer, without the previous existence of constitutional predisposition. That cancer, even when apparently excited by local causes, may in reality be of constitutional origin, cannot admit of a doubt; more especially in those cases in which it is hereditary, or in which it makes its appearance almost simultaneously in different parts of the body, with a strongly marked cachexy. But in many other instances it certainly appears as if it were strictly local in its origin, as when it slowly occurs after the infliction of some

violence, and without any evidence of constitutional disturbance or contamination. We commonly see, for instance, a woman in perfect health receive a blow upon the breast, which gives rise to some passing inconvenience at the time; after a lapse of some months, though still with an unimpaired state of health, she notices a small hard lump. This eventually proves to be a scirrhous tumor. It may continue stationary, or but slowly increase for months or years, until the turning point comes, at which the disease begins to contaminate the skin or the lymphatics, and to be carried into the system, producing cachexy and giving rise to a tendency to the production of those secondary deposits of which we shall speak presently. In such a case as this, it is impossible to look on the cancer as of constitutional origin—that is, as arising from a manifest pre-existent morbid condition of the blood. Still it is difficult to understand, why an injury should in one person be followed by mere hyperæmia and the consequent transitory disturbance of the nutritive changes in the part, while in another the same injury is followed by cancer. We know that an exudation-corpuscle or a pus-cell is the result of strictly local action; and we know also that all persons are liable to the formation of these under favorable conditions. It is true that we are ignorant of the manner in which a cancer-germ can be produced by the local action of the part in which it is generated, but we are as little acquainted with the essential mode of production of the exudation-cell or pus-corpuscle, which we know to be the result of strictly local action; and it seems to me that the difficulty is in no way solved, but simply pushed back a step, by the attempt to prove that, in all cases of cancer-formation, a special condition of the blood must exist, which impresses the cancerous character upon local actions taking place in the system. We only know that it is not every one who is liable to the formation of cancer; and hence it is not very easy to understand how it should arise, unless there was some tendency to its formation—some condition of the body or of the part favoring the production of those forms of growth which constitute the disease. This condition may be one of such low intensity that, as far as regards the practical question of the result of removal of the tumor, we may regard the disease occurring in the circumstances here considered as strictly local in its early stages, and may expect that the removal of the local disease will be followed by a more or less prolonged interval during which the patient shall remain in good health, until perhaps the disposition to the formation of cancer shall have gained sufficient intensity to again manifest itself, either spontaneously or as the result of some fresh form of irritation.

Secondary Deposits of Cancer.—A cancer never remains stationary. It may progress slowly or multiply rapidly. But whether its progress be slow or rapid, it is constant.

The primary cancer has a tendency to multiplication, as well as to vegetative development of the original tumor.

This multiplication of the primary growth constitutes the secondary deposits. These may take place in three ways or rather situations.

1. In the lymphatics and glands leading from the primary growth. The secondary deposits so formed are due undoubtedly to direct absorption of cancer-cells or cancer-juice, and their deposit in the neighboring lymphatics.

2. Primary cancer may multiply itself locally by the formation of more or less numerous deposits in the neighboring cellular tissue, each being a separate nucleus or centre of new cancer-growth. This mode of secondary deposit may possibly be due to the cancer-cells being capable, like

the white blood-corpuscles, of amœboid movements, and thus travelling into neighboring connective tissue spaces by their own power, there to form new centres of disease

3. The secondary deposit may occur in internal organs.

The viscera which are most liable to become the seat of secondary deposits are, first, the liver, and next the lungs. The cause of these deposits is somewhat obscure. Paget is of opinion that in some cases, where a rapid multiplication of cancers takes place, this may arise from an increase in the cancerous diathesis or morbid condition of the blood. But he believes that in most of these cases there has been a conveyance of cancerous material by the blood, in the form of embola; and he supports this view by referring to the analogy pointed out by Walshe as existing between the secondary deposits in cancer and the secondary abscesses in pyæmia; the liver and lungs in both cases being principally affected. He refers also to a case of cancer of the liver, where the growths were colored yellow by the bile, and in which he found cancerous growths of the same color infiltrated in the lungs. This view is supported by the very important observation of Moxon, that in primary cancer of the rectum he has actually found in the secondary deposits in the liver evidences of the rectal origin of the deposit, in the transference with it resembling those of the rectum structures, such as Lieberkühn's follicles, in the secondary cancerous hepatic growths. So also in osteoid we find the secondary deposits in the lungs of a bony character. Paget, however, thinks that it is not necessary to suppose that entire cancer-cells are thus transferred; cancer-juice, or minute fragments of cancer-plasma, may be as efficient as entire cells. Virchow considers that the fact that the secondary deposit does not necessarily occur in the organ through which the blood must first pass, militates against the theory that cancer-cells are carried onward by the circulation, and become impacted in the smaller vessels of the part, in the manner of embola. He inclines to the belief that the cancerous juices are absorbed and enter the circulation either directly by the veins or indirectly through the lymphatics, and that they give rise to changes in the nutrition of certain parts, leading to the development of cancerous growths. But this question necessarily involves the whole doctrine of the formation of secondary deposits, whether cancerous, sarcomatous, enchondromatous, osteoid, or pyæmic—are they the consequence of specific embola, or of changes wrought simply by the absorption of the fluid constituents of these diseases? I incline to the former view, and look on these secondary cancerous deposits just as I do the pyæmic as the direct result of embolism of a specific character in one case, of a septic in the other. This, however, is at present all matter of hypothesis. So far, however, is certain, that in whatever way we suppose the secondary deposits to be formed, we may safely assume that their presence indicates that the system is charged with the material of cancer, and that the disease is no longer limited to the spot in which it first appeared.

Treatment of Cancer.—The treatment of cancer will necessarily be in a great measure dependent on the view that is taken of its origin. The constitutionalists would necessarily and naturally endeavor to discover some method of preventing the development to or of eradicating that blood-poison, or that general tendency which they suppose underlies the local affection, and to lead to its evolution. They would necessarily discard operation as being not only useless, but erroneous in principle—as erroneous as it would be to amputate the foot to relieve or cure the gout. The localists, on the other hand, necessarily rely on

the removal of the primary local disease at as early a period as possible, as the only means of preventing secondary deposits, and consequent constitutional infection. Hence the discussion as to the origin of cancer has a most important practical bearing on the treatment of the disease. All **Curative Constitutional Treatment** is certainly utterly useless, no constitutional remedies appearing to exercise any material influence on this disease. I am not acquainted with any case of cancer, either from my own observations, from conversation with other Surgeons, or from published statements, that afford satisfactory evidence of cure by an internal remedy. It is true that many so-called cases of cancer have, at various times, been stated to have been cured by different medicines; but it must be borne in mind that, in a less advanced state of pathological knowledge than exists at the present day, almost all hard chronic tumors were called "scirrhous," and many intractable ulcers "cancers"; mistakes which are not unfrequently committed, and sometimes unavoidably so, even with the improved means of diagnosis that we at present possess. Not one of the many remedies that have been vaunted as being specific in this disease, and by which cures have been stated to have been effected, has retained the confidence of the profession, or has, on further trial, corresponded in its effects to the statements of those who introduced it. I therefore think it but waste of time to discuss the supposed advantage to be derived from hemlock, sanguinaria, condurango, iron, arsenic, iodine, cod-liver oil, or lemon-juice, in the treatment of cancer. But though curative treatment can effect nothing in these cases, much may be effected in cases that do not admit of operation towards retarding the progress of the disease by proper *Palliative Treatment.* With this view, the diet should be mild, nutritious, easy of digestion, unstimulating, and sufficient to support the strength under the wearing influence of pain and discharge; and the preparations of opium, of conium, and of hyoscyamus, must be freely administered in order to relieve the patient's sufferings, and to procure rest.

The **Local Means** are those upon which the Surgeon justly places the chief reliance in these affections. The **Palliative Local Treatment** consists in the use of means calculated to retard the growth of the tumor, to lessen the pain attending it, and to remove the fœtor that arises if it be ulcerated. In order to prevent the rapid extension of the tumor, it is of great importance to subdue all local excitement within and around it; in proportion to the amount of action existing in the part, the disease will usually extend with rapidity; any inflammatory condition of the neighboring tissues being especially prejudicial in this respect. Hence, in these circumstances, the occasional application of a few leeches will often be of considerable service. No counter-irritation, however, ought to be employed in the vicinity of the cancerous part, as it only excites action in and around it, and hastens the process of ulceration; the skin especially is apt to become rapidly infiltrated by the cancerous disease under it, if irritated by the application of iodine and other stimulants. If the tumor be painful, and the skin covering it still unbroken, great relief may be obtained by the application of belladonna plasters. In some cases I have found powdered conium, spread on cotton-wadding, useful in the same way. As it is of importance to prevent, as long as possible, any breach of surface, the application of these sedative plasters and powders should be persevered in with the view of supporting the integument. The local application of ice, so as to freeze the tumor more or less completely, has been recommended by J. Arnott;

it may, possibly, in some cases retard the growth or lessen the pain, but there is no evidence to show that it can be considered as a curative agent. When the tumor is ulcerated, the fœtor must be diminished by the application of weak solutions of the chlorides, of chloralum, or of Condy's disinfectant, to which opiates may be advantageously added with a view of lessening the pain.

The **Curative Local Treatment** of cancer embraces three methods, viz.: destruction by caustics; absorption by pressure; and removal by the knife. All these local means are employed on one principle, viz., on the supposition that the cancerous tumor which it is proposed to destroy, to absorb, or to extirpate, is primarily a *local* disease: that, if this local malady can be removed sufficiently early, constitutional infection may be prevented; and that, even if this have to some extent taken place, fatal contamination of the system may be retarded by the removal of the local source of that constitutional infection.

The great objection that has been urged against operating in this disease is, that cancer being assumed to be from the first a constitutional affection, it is useless to remove the local tumor, leaving the constitutional vice unrelieved. If this objection were tenable, it would apply to the removal of cancers in any way, and would have as much force against removing cancerous growth by caustic, by pressure, or by congelation, as against extirpating them by the simpler and speedier means of the knife, and in fact must lead to the conclusion that none but local palliatives are proper in this disease. For such an argument as this to have any value, it must first be shown that cancer is always *ab origine* a disease depending on the actual presence in the blood of a certain morbid material, and that it is not in many cases primarily local, in so far that any tendency to the formation of cancer has strictly limited its action to the part where we find the cancer developed The arguments which have already been adduced, however, and the results of experience, appear to me to be conclusive as to cancer being, for all surgical purposes, primarily a local disease, and only becoming constitutional secondarily by contamination of the blood and absorption into the system, and consequently to justify operation for the removal of cancerous tumors in suitable cases.

Caustics.—The employment of caustics for the destruction of cancers has, in all ages and countries, been resorted to by empirics, who profess to remove tumors of a malignant nature, by secret remedies, less painful and more effectual than the knife. As their application, to use Velpeau's expression, requires neither a knowledge of anatomy nor of operative surgery, these remedies have always been popular with many who have neither the knowledge nor the skill to use the knife In this country, however, they have never enjoyed any very extended reputation; and in fact they have, perhaps, not been legitimately employed to the extent that they deserve, especially in ulcerated and recurrent cancers, or in those so situated on the skin and muco-cutaneous surfaces as not to admit of being very readily or safely extirpated by operation.

The great objection to the use of caustics has been the severity and the continuance of the pain induced by them, which lasts not only for hours, but for days—more intense and prolonged than any occasioned by the knife; and as it is usually necessary, in order to destroy effectually the morbid growth, to repeat the application of the caustic several times, the suffering is often greater than the most resolute patient can submit to.

The chief argument in favor of the use of caustics is the statement,

that cancers thus destroyed are less liable to recur than when extirpated by the knife. There is, however, no positive evidence before us in proof of the truth of this opinion. It is not improbable that the chemical action of the caustics may extend so widely into neighboring tissues as to destroy or render unproductive the cancer-cells or cancerous plasma by which they are infiltrated, and on the development of which the local recurrence of the disease depends. But it is impossible to believe that the mere method of removal of the local disease can influence the constitutional nature of the cancer. If secondary infection have taken place, it can signify very little whether the local disease be extirpated by the knife or by caustics. If no cachexy exist, it appears to me that the patient must be equally safe in whatever way the local disease is removed, provided it be thoroughly and effectually extirpated. Another advantage urged in favor of caustics, in the correctness of which Velpeau acquiesces, is, that enlarged lymphatic glands are more likely to go down under their use than when the primary cancer is extirpated by the knife. Some of the advocates of the use of caustics in the treatment of cancer pretend that the particular agent employed exercises on the morbid structure a specific action, which is confined to it, and does not extend to the neighboring healthy tissues. But this assertion is entirely destitute of foundation.

The caustics that have been and that are employed in the treatment of cancers are very various. They cannot be used indiscriminately, and consequently we must briefly consider them separately.

1. The *concentrated mineral acids*, especially the fuming nitric and anhydrous sulphuric acids, are often advantageously employed. The concentrated nitric acid may be usefully applied to small superficial cancerous ulcers; it rapidly destroys the tissues, and does not spread too widely, but it is not potent enough for the destruction of tumors. The glacial sulphuric acid, made into a white paste with asbestos, as used by Michel, or rubbed into a black paste with powdered saffron, is the caustic which Velpeau extols as the most efficient in cancerous tumors, more particularly those of a fungating or bleeding kind. It converts the part to which it is applied into a thick, hard, carbonised eschar, with but little surrounding inflammation; and, as its action is rapid, the pain is not prolonged. On the separation of the hard slough, a healthy granulating cavity will be left, which cicatrises rapidly with much contraction. It also acts as a hæmostatic, rapidly shrivelling and drying up large bleeding and discharging fungi.

2. The *caustic alkalies*, especially potash and lime, either alone or in combination, in the shape of the Vienna paste, or fused into sticks, are very energetic in their action; but they have the disadvantage of spreading widely if applied to a large surface, and, by softening or dissolving the parts, giving rise to a tendency to hæmorrhage. They may, however, be advantageously applied to small cancers of the face.

3. Various *mineral salts*, more particularly the chlorides of antimony, zinc, and bromine, the acid nitrate of mercury, and arsenious acid, are often employed with much success in the treatment of cancerous ulcers and growths.

Of the various *chlorides*, that of *zinc* is the most useful. This is applied by being made into a paste containing one part of the chloride to four parts of flour, moistened with a little water, or by the pure chloride slightly moistened being spread on strips of lint. It must, in order to act, be applied to a raw surface: hence it is customary first to destroy the skin with nitric acid, and then to apply the chloride. Canquoin

states that a paste, made of equal parts of the chloride and of flour, four lines in thickness, and applied for forty-eight hours, destroys the parts to the depth of an inch and a half. When of less strength and substance, its action is proportionately limited. There are two methods by which a tumor may be attacked and destroyed by caustic paste: either at or from the circumference, or from the centre. When the tumor is large and rapidly growing, it may be most advantageously destroyed from the circumference, at its junction with the healthy tissues. This may be done by the plan adopted by Maisonneuve—of making the paste into small sticks, or pencils, which are pushed deeply and at short intervals into the substance of the tumor around its circumference, so that its tissue becomes penetrated by the action of the caustic in all directions, and its vitality thus rapidly destroyed. In small tumors, and those that grow with less rapidity, in which there is no great risk of the rapidity of their growth overtaking and passing beyond the destructive effects of the caustic, the paste may be applied to and around the centre, and the disease in this manner extirpated. In other cases, the tumor may be deeply and rapidly attacked by applying a layer of the chloride of zinc paste over the whole of its surface. The slough produced by this application is then incised, or scored longitudinally at equal distances of about half an inch, until the parts beneath, to which the caustic has not penetrated, are reached by the incisions so made: pieces of lint covered with the deliquesced chloride are put into them, and afterwards fresh incisions are made until the cauterising influence has extended to the bottom of the tumor, which finally sloughs out in a mass. Of the utility of the chloride of zinc as a caustic, there can be no doubt; but the chief objection to its use lies in the intensity and continuance of the pain occasioned by it. This, however, may be lessened by an admixture of about a sixth part of morphia, or, as L. Parker has suggested, by freezing the part before the caustic is applied, and continuing the application of the frigorific mixture during the time of the action of the caustic. Landolfi has recommended the use of the chloride of bromine in combination with those of gold and zinc; but this caustic does not appear to possess any decided advantage over the simple chloride of zinc, and is objectionable on account of the fumes evolved during its use.

Arsenic exercises a powerful action upon cancerous growths, and is the chief ingredient in many of the secret preparations used by empirics; it is, however, a dangerous agent, and excites great inflammation and pain. If too freely used, it may induce poisoning, and not a few deaths have resulted in this way; it should, accordingly, not be applied at any one time to a surface exceeding a shilling in size. The most convenient mode of applying it appears to be Manec's paste, composed of one part of arsenious acid to eight of cinnabar and four of burnt sponge, rubbed down to a proper consistence with a little water.

Sulphate of zinc, dried, finely levigated, and made into a paste with glycerine, or an ointment with lead, has been very strongly recommended by Simpson, as one of the most efficient and convenient of all caustics in rodent and cancerous ulcers. In action it somewhat resembles the chloride of zinc, but is less painful.

Of all these caustics, I should certainly say that the deliquesced chloride of zinc is the safest and most efficacious, more particularly when a scirrhous tumor has to be destroyed. When an encephaloid fungus has to be attacked, the concentrated sulphuric acid is preferable, owing to its coagulating and hæmostatic properties. When small cancerous sores have to be destroyed, the nitric acid, the arsenical paste, or the chloride

of zinc, made into a paste with flour and morphia, may very conveniently be used.

Compression is a plan that has been alternately greatly extolled and much depreciated. It was fully tried at the Middlesex Hospital, by Young, more than fifty years ago, and unfavorably reported upon by Sir Charles Bell at that time; it consequently fell into disuse in this country, but was revived by Recamier in France, and employed largely by him. Although he published a favorable account of this practice, it made but little progress amongst French surgeons; the only one who seems to have used it to any extent being Tanchou, who employed a peculiar topical medication conjoined with it. In this country the practice fell into complete oblivion, until J. Arnott some years ago invented a mode of employing pressure by means of an elastic air-cushion; since which time it has been often employed with varying degrees of success.

In employing pressure, Young principally had recourse to plasters and bandages. Recamier used amadou applied with an elastic roller; and Tanchou recommended spring-pads, under which small bags or pieces of cotton-wadding impregnated with various medicinal substances were placed, so as to protect the skin and act upon the tumor. Arnott's plan consisted of pressure exercised by a Macintosh air-bag, held in its place by straps, and pressed upon by a truss-spring, the pressure exercised by which was made to vary from two-and-a-half to twelve or even sixteen pounds. These different plans should not be employed indiscriminately, but may all be of service in particular cases. I have employed them all, but have never found permanent advantage from any of them.

The first question that necessarily arises in reference to the employment of pressure in these cases is, whether it can effect a cure. This it could only be expected to do by producing atrophy, and subsequent absorption, in the strictly local forms of cancer The only case on record, with any pretension to a conclusive character in this respect, is one related by Walshe in his excellent *Treatise on Cancer*, of a cure of a tumor of the breast believed to be cancerous, by compression.

But even this instance I cannot look upon as by any means conclusive; for, although no one can entertain a higher opinion than I do of the very remarkable diagnostic skill possessed by Walshe, yet I think there can be no doubt in the mind of any Surgeon that it is absolutely impossible to determine in many cases, by any amount of knowledge or skill, the true nature of a chronic tumor of the breast; and, in fact, the most experienced practitioners frequently find, after the removal of the tumor, that it was of a different character from what they had previously anticipated. This difficulty attaches to Walshe's case; and I think that there is no proof that the tumor of the breast, which underwent absorption under the pressure of Arnott's apparatus, was of a truly cancerous nature, and that it was not a chronic mammary tumor, or some similar growth which, as every one knows, will disappear under this kind of treatment.

But, if compression cannot be shown ever to have cured a cancer, can it not retard the progress of this disease, or relieve the sufferings attendant upon it? I believe that in some cases, it may certainly do both, though in others it is as unquestionably injurious. It appears occasionally to retard the growth of the tumor when applied in the early stage, simply by preventing its expansion, and perhaps by compressing its nutrient vessels, and so diminishing the supply of blood sent to it, and

by causing absorption of surrounding inflammatory infiltration; in these cases likewise it relieves for a time the pain by lessening the turgescence of the part. In other cases, however, I have known it to act injuriously by pressing out and diffusing the tumor more widely, appearing to increase the tendency to implication of neighboring parts, and occasioning great suffering. When the tumor is ulcerated, or if the skin covering it be inflamed, pressure cannot be employed with any advantage; and most commonly irritable sensitive patients cannot support the constriction of the chest that it necessitates.

Excision.—With regard to the question of removing cancers by the knife, much difference of opinion exists amongst Surgeons; for, though all deprecate indiscriminate recourse to this means, some go so far as to dispute the propriety of ever operating for this disease, whilst others would restrict the operation to certain cases of a favorable character. These divergences are necessarily of considerable importance, and require attentive examination.

The objections that have been urged against the general propriety of operating in cases of cancer, do not apply so much to the operation itself, the risk attending which is not greater than that of other operations of similar magnitude, but are rather based on the supposition that cancer is originally a constitutional affection, and that the patient is consequently liable to speedily suffer from a return of the disease, so that an operation that is at least unnecessary will have been performed. This objection, however, as has already been remarked, equally applies to all other means of local removal, as by caustics or compression, as well as to extirpation by the knife; and if carried to its logical conclusion, must necessarily preclude any attempt at removal, by any means, of the local disease. That this objection, so far as the liability to return of the cancerous disease after operation is concerned, is to some degree a valid one cannot be gainsaid; the experience of all Surgeons tending to establish the fact, that the majority of patients operated upon for cancer die eventually, and usually within a limited time, from a recurrence of the disease. Thus, A. Cooper states, that in only nine or ten cases out of a hundred did the disease not return in three years; and Brodie has found that it generally proves fatal in two or three years after the operation.

After removal of the original cancerous tumor, the disease may return in one of three situations, viz.: in the cicatrix; in the neighboring lymphatic glands, with or without implication of the cicatrix; or in internal organs. The mode of recurrence in these different parts is obvious enough. When the disease returns in the *cicatrix*, it is owing to local causes; either to the original cancer having been imperfectly removed, when recurrence will take place before the wound is healed, or very shortly after this event; or to the widely spread infiltration of cancer-germs through tissue that had a healthy appearance, when recurrence will take place after a lapse of some weeks or months, in the shape either of uniform infiltration of the cicatricial tissue, which assumes the appearance of an elevated hard ridge of a purplish-red color, or of nodules which rapidly coalesce. When it recurs in the *lymphatic glands*, it is because they were infiltrated with the cancer-germs before the removal of the original tumor. They become hard, and often develop into secondary growths, rivalling the primary disease in size and rapidity of growth. When the secondary deposit takes place in *internal organs*, it is usually met with in the liver or the lungs. In such cases it is reasonable to presume that cancer-cells or portions of cancer-plasma enter the blood, are

carried into the general current of the circulation, and are deposited in these organs, there forming the nuclei of new growths.

Recurrent cancer, in whatever situation it may occur, is more rapid in its course than the primary form of the disease. It may prove fatal in various ways: by exhaustion from local discharges or hæmorrhage; by the induction of an anæmic cachexy, in which the nutrition of the system becomes so impaired that death results from inanition; or by the induction of internal disease of an acute character, as low pneumonia, pleuritic effusion, or ascites, according as the internal deposit is thoracic or abdominal. The disease is especially apt to recur soon if the skin have become involved, if the lymphatic glands be enlarged, or if there have been constitutional cachexy before the operation; also if the tumor be growing rapidly at the time of removal, and especially if the patient be robust and strong, with a florid complexion.

In determining the advisability of operating in cases of cancer, several questions of great importance present themselves to the consideration of the Surgeon. He has at first to consider whether the operation is likely to rid his patient completely of the disease; or, in the event of its not doing so, whether life may not be prolonged by the removal of the cancerous tumor; or lastly, whether his sufferings may not be much lessened by the removal of the local affection, although there be no prospect of really prolonging life.

The principle on which all operations for the removal of cancer are undertaken is this: either that, the disease being local *ab origine*, the constitutional and secondary manifestations can be prevented by a timely removal of the local and primary deposit; or that, even if the tumor be the result of a constitutional predisposition or vice roused into activity by local causes, the excision of this morbid deposit removes from the system a new centre and source of constitutional infection; so that, if the operation be unsuccessful in completely eradicating the disease, it may yet be productive of much good in preventing the contamination of the system from this new centre of morbid action. The two following questions will therefore present themselves to the Surgeon in considering this subject.

1. Can cancer be cured, or rather completely extirpated from the system by excision?

That in some cases a cancerous tumor may be removed with every expectation of the patient being completely freed from the disease, cannot, I think, be doubted; although it may be true that such instances are rare. Yet they do occasionally fall under the observation of Surgeons, and certainly seem to prove that the affection is not in all cases constitutional, and that, if happily we can exceed in removing it during its local condition, there is a good prospect that the patient may be rescued from a return of the affection. Velpeau states that he has perfectly cured patients by the removal of cancerous tumors—at least, that no return has taken place for 12, 15 or 20 years after extirpation. The evidence of Brodie on this point is extremely valuable; writing in 1846, that eminent Surgeon states, that "So long ago as 1832, I removed a breast affected with a scirrhous tumor, and the lady is still in good health—at least, she was so last year. Since the operation she has married and had children. Last year I was called to see a lady on account of another complaint, on whom I performed the operation thirteen years ago, and found that she continued free from the old disease; and, very lately, I have heard of another lady whose scirrhous breast I removed six years ago, and who continues well." The opinion of Fergusson is

also very positive on this point, and he speaks in a tone with which I perfectly agree. He says: "Nevertheless, as excision gives the only chance of security—a point on which most parties seem to agree—an operation should always be resorted to, provided the knife can be carried beyond the supposed limits of the disease; and, moreover, I deem it one of the duties of the practitioner to urge the patient to submit to such a proceeding." The opinion of these eminent Surgeons, supported as it is by the general practice of the profession, tends to show that in some cases, at least, the disease may be extirpated from the system by excising the tumor before the constitution has become implicated.

2. If cancer cannot be actually cured by excision, may not life be prolonged and health improved by an operation?

I am decidedly of opinion that this is possible; and that, though a patient may at last be carried off by some of the recurrent forms of cancerous disease, health may have been improved, life may have been prolonged, and much suffering may have been spared by a timely operation. It may often be observed that, after the cancer has been removed, the digestion becomes stronger and the patient gains flesh; the color of the complexion returns, and the spirits greatly improve; the system being relieved from a source of local irritation, and the mind from a cause of disquietude that has undermined the general health of the patient. This is more particularly the case in encephaloid cancer, in which early removal of the disease is unquestionably successful, in many cases, in prolonging life. The observations of Paget on this point are peculiarly valuable. He states the average duration of life of those patients laboring under this form of disease, in whom the primary affection is removed, to be about twenty-eight months; whilst the average life of those in whom the disease is allowed to run its course, is not more than two years.

I think that the introduction of anæsthetic agents into operative surgery has very materially affected the bearings of this important question. So long as an operation was a source of great pain, and of much consequent anxiety and dread, a Surgeon might very properly hesitate to subject his patient to severe suffering with so doubtful a result; but now that a patient can be freed by a painless procedure from a source of great and constant annoyance, discomfort, and suffering, the Surgeon may feel himself justified in thus affording him a few months or years of comparative ease, though he may be fully aware that, at the expiration of that time, the affection may return, and will then certainly prove fatal. Even under these circumstances, the patient's condition may be much improved; for the recurrent is frequently less distressing than the primary disease, since, as it often takes place in internal organs, it is not attended with the same amount of local pain and distress.

In discussing the propriety of operating in a case of cancer, the Surgeon can, however, have little to do with general or abstract considerations. He has to determine what had best be done in the particular case; and it will serve him little, in coming to a conclusion as to the line of practice that he should adopt, to refer to the statistics of the gross results of operations, or to general comparisons between the results of cases that are not operated upon and those that are. The whole question narrows itself to the point, as to what should best be done in order to prolong the life, or relieve the suffering of the particular individual whose case is being considered. In order to come to some definite conclusion on this, it is necessary to classify the different cases of cancer, and to arrange them under the heads of those in which no

operation is justifiable: those in which the result of any such procedure would be very doubtful; and those in which an operation is attended with a fair prospect of success.

1. *Cases not proper for Operation.—a.* The operation ought never to be performed in cases where several cancerous tumors exist in different parts of the body at the same time. Here the disease is evidently constitutional, and cannot be eradicated by any series of operations. *b.* If the cancerous cachexy be strongly marked, or if the disease be hereditary, it is useless to remove a local affection; as the malignant action will certainly manifest itself elsewhere, or, perhaps, even speedily return in the cicatrix. *c.* If the tumor be of very rapid growth, and still increasing, there would appear to be so vigorous a local tendency to cancerous deposit, that it will speedily develop itself again in the cicatrix. *d.* If the tumor be so situated that it cannot be completely and entirely extirpated by cutting widely into the surrounding parts, it ought not to be meddled with; otherwise the affection will to a certainty return in the wound before it has closed. It is necessary to remove not only the tumor, but the surrounding tissues to some extent, even though apparently healthy. *e.* If the whole of the affected organ, as a bone, cannot be removed, or if the skin and glands be involved, it is useless to attempt the extirpation of the growth, as a speedy relapse will certainly ensue. *f.* In the very chronic and indurated cancers of old people, it is often well not to interfere, as in these cases the affection makes such slow progress, that it does not appear in any way to shorten life, and the mere operation might be attended with serious risk at an advanced age.

2. *Doubtful Cases.*—Those cases in which the result of an operation is extremely doubtful, but in which no other means offer the slightest prospect of relief, have next to be considered. *a.* Cancers of the eye, tongue, and testes, belong to this category; for, though more liable to return than similar affections of any other part of the body, yet they may be considered fit cases for operation, inasmuch as in no other way has the patient the slightest chance of being relieved from his disease. *b.* In cancers that are already ulcerated, the Surgeon may sometimes operate in order to give the patient ease from present suffering, or, perhaps, as in some cases recorded by Brodie, with a view of prolonging life; but he can have little expectation of effecting a permanent cure. *c.* If the tumor be so large, or be so situated, that its removal cannot be undertaken without so serious an operation as to occasion in itself considerable risk, the propriety of operating is always very doubtful.

3. *Cases proper for Operation.*—Those cases of cancer in which an operation is, in my opinion, not only perfectly justifiable, but should be urged upon the patient as affording the best prospect of preserving life, are those in which the disease has appeared to originate from a strictly local cause in persons otherwise in good health, and in whom there is no cachexy or hereditary taint. If the tumor be of scirrhous character, slow in its progress, single, distinctly circumscribed, without adhesions to or implication of the skin or glands, and more especially if it be attended with much pain, or with immediate risk to life from any cause, and if the whole of the growth, together with a sufficient quantity of the neighboring healthy tissues in which it is embedded, can be removed with ease, the case may be looked upon as a fit one for operation. In all encephaloid cancers also, early operation should be practised with the view of prolonging life.

An important question in connection with operations for cancer is, at what period of the growth they may be done with the best prospect of

success. Most Surgeons, taking a common-sense view of this question, are in favor of removing the affection as early as possible, feeling that, as it is difficult to say when the local form of the disease becomes constitutional, it is safer to remove it as soon as its true nature has been ascertained; and I confess that I can see no advantage that can be gained by delay. The necessity for early operation in *medullary* cancer is admitted by all; but with regard to *scirrhous* cancer the opinion is entertained by some, that in many cases there is a better prospect of success if the operation be delayed; and it is stated by Hervez de Chégoin and Leroy d'Etiolles, that the result of those cases operated on after the cancer has lasted for some time, is more favorable than that of those in which an early operation has been done; the cancer often appearing to be arrested in its development, and to localise itself, as it becomes more chronic, and having consequently a less tendency to speedy return after removal. That the result of operations in such selected cases is favorable, is probable enough; as it may be reasonably supposed that the more active varieties of cancer, those that possess the greatest amount of vegetative activity and of reproductive power, may have acquired a condition unfavorable to operation, or may even have carried off the patient before any period of arrest in their growth has occurred, during which their extirpation could be practised with a fair prospect of success. In delaying operation there is, however, much danger lest valuable time be lost in the employment of means which, ineffectual in arresting the disease, may become positively injurious by allowing time to the morbid growth to contaminate the glandular system, or to extend widely through neighboring tissues. If we look upon a cancer as a growth which must necessarily destroy life, either by changes taking place in its own substance or by the contamination of the system, and which is intractable to all medication, whether topical or constitutional, we must regard its extirpation as the only resource that Surgery offers; and we may assuredly infer, that the liability to constitutional infection and wide-spread local contamination will be less in proportion to the early removal of the morbid mass.

EPITHELIOMA.

Epithelioma, though closely allied to the true cancers, differs from them in so many important respects that it requires to be considered as a distinct affection. It resembles the true cancers in its tendency to local infiltration and ulceration, in its extension to the lymphatic system, and in the induction of death by cachexy. It differs from them in its anatomical structure, in being invariably seated in the mucous, muco-cutaneous, and more rarely the cutaneous structures—always primarily on a mucous or cutaneous surface, where epithelial cells are naturally found, and in its being rarely attended by secondary deposits in the viscera. Some writers have gone so far as to deny any relationship between epithelioma and the true cancers, and others again have looked upon it as a semi-cancerous formation (cancroid of Virchow); there can be no doubt, however, that it is a true cancer, for forms intermediate in structure between it and scirrhus are not unfrequently found. Epithelioma must be carefully distinguished from simple papilloma; though this is not always easy, for as on one side epithelioma may merge into scirrhus, on the other it passes by insensible gradation towards the simple wart. In epithelioma the epithelium is found not only growing on the surface of the skin or mucous membrane, but forcing its way downwards amongst the parts beneath in cylindrical or irregular processes,

forming so-called cancer-cylinders. Probably many tumors, ultimately cancerous, pass through a stage undistinguishable from simple warty growth.

Situation and Progress.—Epithelioma, rare in the young, is common in middle-aged or elderly people, the tendency to it increasing in proportion as age advances. In this respect it follows the course of other cancers. It is generally occasioned by the long-continued or frequently repeated application of some source of irritation, and may thus be established in constitutions otherwise perfectly healthy. Thus, the irritation of a broken tooth upon the tongue or cheek may produce epithelioma of those parts. The scrotum in chimney-sweepers not unfrequently becomes the seat of epithelioma, in consequence of the lodgment and irritation of soot in its rugæ. The muco-cutaneous surfaces are its true habitat; it chiefly occurs in the lips (Fig 310), tongue, mouth, eyelids, penis, vagina, and anus. It is, however, also met with in the cutaneous surfaces of the face, the hands, the feet, and the scrotum; and, indeed, may occur upon any cutaneous surface, although there can be no doubt that those tubercles and malignant ulcerations that occur in the purely cutaneous surfaces of the extremities and trunk are occasionally scirrhous. It commences either as a small flat tubercle or wart, which rapidly ulcerates; or it appears from the first as an intractable fissure or ulcer of limited size, with hard and everted edges, and a foul surface. Such an ulcer as this may not only attack and destroy the soft parts in its neighborhood, but may equally produce its destructive action on bones, penetrating deeply into their structure and eroding them. It slowly spreads, and appears at first to be local; but after a time, contaminating the glands in the neighborhood, it induces cachexy, and destroys the patient by exhaustion. Epithelioma, however, is not always external: it may develop from deep mucous surfaces. Many of the so-called malignant polypi of the nose—naso-pharyngeal and antral tumors—are of this nature. I have seen an epithelioma as large as a small orange, developing in this situation, and passing into the orbit and to the cheek. In the larynx, pharynx, and œsophagus, the bladder, the uterus, and other organs of this kind, it is also met with. In fact, from any part of the body that is naturally provided with epithelium, and from such surfaces only, epithelioma may be developed. The only apparent exception to its occurrence on the surfaces covered by epithelial or epidermic scales with which I am acquainted, is its appearance as a submucous tumor in the mouth and uterus, of which I have more than once seen instances in both of these situations; the tumors varying in size from a cherry to a small walnut, round, pedunculated, and fibrous looking, but presenting after removal the characteristic epitheliomatous structure. An epithelioma developing upon the integumental surfaces may extend deeply, and thus affect or destroy subjacent organs. Thus from the eyelids it may invade and disorganise the eyeball; from the scrotum it may implicate the testis; from the skin it may penetrate into and destroy the subjacent bones, as we see in the face and occasionally in the tibia. Extensive secondary deposits in the lymphatic glands in the vicinity of

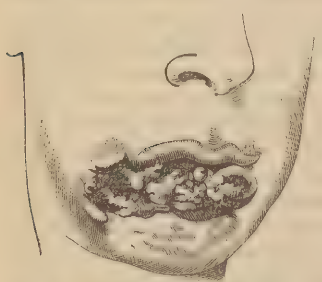


Fig. 310.—Epithelioma of Lower Lip. Male: about 21.

the parts affected, even deep in the submaxillary, iliac, and pelvic regions, invariably take place after the disease has lasted for some time.

Structure. — On microscopic examination, an epithelioma will be found to be composed of masses of cells of the type of squamous epithelium, forming irregularly cylinderical processes communicating with each other. From the irregular course of these processes, they are cut in a variety of directions in every thin section, so that the groups of cells do not give the idea of cylinders, but rather of circular, oval, and irregular masses not in direct connection with each other. Between these cylinders is a fibrous tissue bearing abundant vessels for the nutrition of the non-vascular epithelium. This fibrous tissue is more or less infiltrated with small round cells, in proportion to the rapidity of the growth of the tumor. It will be seen from the above description that the structure of an epithelioma, although differing in detail, is in the main similar to that of scirrhous and encephaloid cancer; that is to say cells of an epithelial type, imbedded in spaces in a fibrous stroma, which freely communicate with each other (Fig. 311).

Fig. 311.—Epithelioma of Anus (40 diam.). Shows the lobules extending down into the connective tissue, which is infiltrated with small round cells; four globes are seen. The isolated masses are probably cylinders cut obliquely.

As in normal squamous epithelium covering a papilla of the skin, the cells next to the fibrous and vascular tissue are softer and rounder in form than those of greater age. In the centre of the terminal portion of a cylinder of cells or in a branching process from it, the epithelium often becomes flattened by pressure, and arranged circularly so as to form a globe (epithelial nests, epithelial pearls). These nest-like formations are produced, according to Virchow, by the remarkable tendency to endogenous cell growth exhibited by some of these cells, and the development of large "brood-spaces" within them. The pressure produced by this formation of brood-spaces, and the endogenous cell-growth ac-

companying it, causes the cells to become flattened and to take on a concentric arrangement. Possibly these globes may be formed in both ways; but the appearance usually presented by them rather suggests the former than the latter process, as the central parts are most frequently dry and hard, and present no signs of active growth. Similar globes are not unfrequently formed in simple warty growths, and must therefore not be considered absolutely diagnostic of epithelioma. The fully formed cells often present beautifully serrated edges, the serrations of one interdigitating with those of its neighbors. This is well shown in the accompanying drawing (Fig. 312), taken from a small epithelioma of the anus which I removed in University College Hospital. The individual cells of an epithelioma, a obtained by scraping, differ but little from the healthy scaly epithelium that may be got from the mucous membrane of the cheek or lip. They are often larger, and sometimes contain more than one nucleus. In the older parts of the growth, they are usually filled with fat-granules. When an epithelioma has undergone ulceration, the surface is frequently covered with prominent masses like large granulations, and the diagnosis of the nature of the growth can often be made by removing one of them and submitting it to microscopic examination. If in a simple ulcer the skin be completely destroyed, epithelium is never found except at the margins; in an epitheliomatous ulcer, on the contrary, it is found at every part of the ulcerating surface. The *vessels* of epithelioma are abundant, but not so plentiful as those of scirrhus or encephaloid. Of the relation of the growths of the *lymphatics*, there is some difference of opinion. Thiersch and Waldeyer believe that they have demonstrated a lymphatic endothelium covering the cylinders of cells, and consequently believe that the epithelium is actually within lymph-spaces. The anastomosis between the cancer cylinders is said exactly to resemble that normally seen between the lymph-spaces. Köster believes that the epithelium of the cancer is in reality produced by multiplication of the lymphatic endothelium.

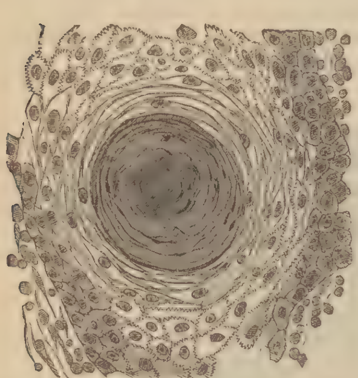


Fig. 312.—Epithelioma of Anus (188 diam.). Illustrates the structure of an epithelial globe, and shows the spinous cells which occur normally in the Malpighian layer of the skin.

Although the local characters of an epithelioma may in some cases be distinguishable with difficulty from those of true cancer, there is a very important pathological difference between the two diseases; for in epithelioma those secondary affections of the viscera which are so common in and characteristic of true cancer rarely occur. When epithelioma proves fatal, it is usually by the progress of the local disease; by its extensive ulceration; by the contamination of the neighboring lymphatic glands; and by the consequent induction of a constitutional cachexy and malnutrition, with exhaustion of the system. But those secondary tumors which are met with in the liver, lungs, &c., indicative of a deeper contamination of the system than is shown by glandular deposits, and which are the characteristic and almost invariable accompaniment of other forms of cancer, seldom occur in epithelioma.

Diagnosis.—The diagnosis of epithelioma from the other forms of cancer is not always easy. The principal points that should guide the Surgeon are: 1. The almost invariable occurrence of the epithelioma on the mucous or muco-cutaneous surfaces. 2. Its early ulceration; often from the very commencement, as the primary form of the disease. 3. The rapidity with which ulceration follows on the new growth, so that the disease may appear to spread by ulceration rather than by new deposit. 4. The origin of the disease from some evident source of external irritation. 5. The absence of all evidence of contamination of internal organs. In making the diagnosis, it must be borne in mind that scirrhus, when affecting the mucous or cutaneous surfaces, usually commences as a tubercle; and that, when this ulcerates, the base of the ulcer has a hard and deeply infiltrated feel, extending for some distance into the tissues, whereas epithelioma is superficial, and is ulcerated rather than tuberculated and infiltrated.

The **Prognosis** of epithelioma is far more favorable than that of true cancer in any of its varieties.

Treatment.—The treatment of epithelioma is much more satisfactory than that of the other varieties of carcinomatous disease which we have just been considering, inasmuch as this partakes more of the characters of a local, and less of a constitutional affection, than the other forms of cancer. Constitutional treatment is, I believe, as ineffectual in epithelioma as in the other forms of cancer; but early and free removal by excision or ligature, or complete destruction by caustics, will not uncommonly permanently rid the patient of this affection. Indeed, if the operation be done sufficiently early, I believe there is little liability to relapse. I am acquainted with several cases in which from six to ten years have elapsed from the date of the operation, without a sign of a tendency to recurrence of the disease. Paget refers to a case in which thirty years elapsed after the removal of a scrotal cancer before the reappearance of the disease. But great risk of recurrence arises from the delay of operation and the employment of inefficient means. The operation may be successfully practised at almost any age. I have removed an epithelioma of the tongue from a man 85 years of age with perfect success.

Excision should always be preferred whenever practicable, and should be done as soon as the nature of the disease is recognised, the part being thoroughly removed together with a wide margin of tissue, on each side of and beneath it, so that no germs may be left from which new growths may spring. When the neighboring lymphatic glands are but slightly enlarged, the operation may still be done; the glandular enlargement, which may be dependent on irritation, gradually subsiding. If, however, the enlargement be more considerable the affected gland must be extirpated; but if there be a chain of enlarged glands, more especially in the deeper cavities, no operation should be undertaken, as the disease will then have become constitutional. If the disease be situated on one of the extremities, as the hand or foot, partial or complete amputation may be the safest procedure; and such cases are less liable to relapse than others in which such free extirpation is not admissible.

The *Ligature* may be advantageously employed when the cancer is so situated that excision is impracticable, either on account of dangerous hæmorrhage, or from the impossibility of effectually extirpating the disease. The part having been well insulated, and effectually strangled by stout whip-cord ligatures, sloughs and separates in a few days.

By means of the *Écraseur* (Fig. 313), cancroid and other growths of

considerable size are removed with little or no hæmorrhage, in the course of a few minutes, by a process of rapid strangulation and crushing in a linear direction. The écraseur consists of a loop of chain of fine steel or twisted wire, which, having been passed over the tumor or through the

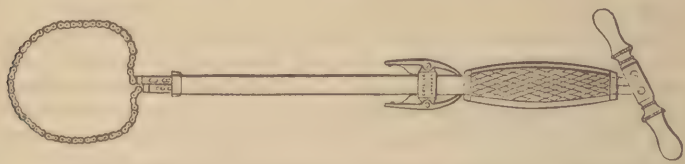


Fig 313.—Chassaignac's Steel Chain Écraseur.

tissues to be removed, is gradually tightened by a mechanism in the stem to which it is attached. In applying this instrument it is often necessary, first of all, to insulate and raise the tumor to be removed by passing a thread through or under it (Fig. 314); and then, having

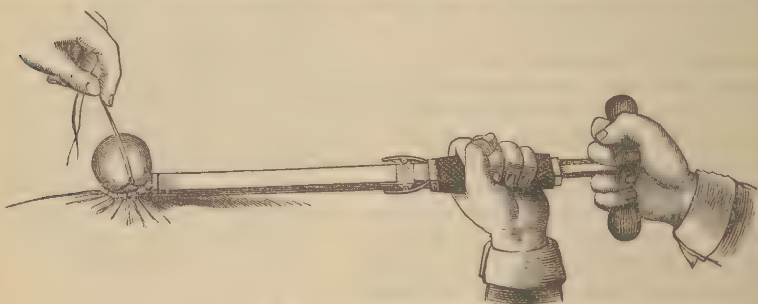


Fig. 314.—Écraseur applied.

applied the loop of the chain round its base, to tighten this and effect the strangulation by working the handle every ten or fifteen seconds, until the mass is detached. The resulting wound is small and puckered in, and often heals with but little trouble. If the mass to be removed be large, two or more écraseurs may be used at the same time, the chains having been passed through the tissues by means of a needle. The action of the écraseur differs according to the kind of instrument used. Chassaignac's original écraseur, armed with a steel chain, and having a to-and-fro movement, acts like a saw. That which is now often employed (*vide* vol. ii., Diseases of the Tongue) acts as a simple constrictor; and its use is therefore less likely to be followed by hæmorrhage. This instrument appears to me to be chiefly applicable to cases in which, as in cancroid ulcer of the tongue, excision is hazardous on account of the hæmorrhage attending it, while the ligature is objectionable on account of the fœtor and discharge resulting from the slow separation of the constricted mass, which sloughs and becomes putrescent. The French Surgeons, however, extend the use of the écraseur to many cases in which in this country the ligature or the knife is preferred. They suppose that pyæmia is less likely to follow removal by this instrument than by the more ordinary means, purulent absorption less readily occurring while the vessels on the cut surface are crushed together. Whether this be really so, remains to be proved.

Caustics.—In some instances, the disease being so situated, as in some parts of the face, or in the deeper cavities of the body, that it cannot be dissected out, the application of caustics will be useful in procuring its removal; but, if these agents be employed, care should be taken that they be freely applied and be sufficiently strong, so as thoroughly to destroy the whole of the morbid textures. Inefficient caustics, such as nitrate of silver, irritate and do not destroy the tissues to which they are applied, and in this way do much mischief. Inflammation is excited around the cancroid growths, plastic exudation takes place, and this becomes rapidly infiltrated by the abnormal structure, which thus extends with much greater rapidity than would otherwise have been the case. The best caustic preparations are the concentrated sulphuric acid, arsenic, and chloride of zinc paste, fused potassa cum calce, the potassa fusa, the Vienna paste, and the acid nitrate of mercury (*vide* p. 780). All of these may be applied successfully, though they should not be used indiscriminately. The chloride of zinc and the Vienna paste are most useful when the ulcerated surface is large, and indurated at its base or edge. The acid nitrate of mercury should only be employed when the sore is small, superficial, irregular, and without much induration. In such cases also, the arsenical pastes and powders already described are very useful.

When a recurrence takes place after operation for epithelioma, it is either by a fresh deposit of cancerous matter in the cicatrix, or else by the neighboring lymphatic glands, which had been contaminated before the operation, continuing to enlarge and at last ulcerating, and thus destroying the patient by cachexy and exhaustion, but (except in very rare cases) without the occurrence of secondary deposits in internal organs.

Recurrence.—Epithelioma, when it recurs after removal by operation, may do so in three different ways.

1. *By Local Reproduction.*—This is the most ordinary mode of recurrence—the disease appearing again after a time in the cicatrix, or in neighboring lymphatic glands which are on a line with the cicatrix, whether reproduction have taken place in it or not. In this mode of recurrence it is probable that epitheliomatous cells had either been disseminated more widely than was supposed in tissues that appeared healthy, and thus developed anew in the lips of the wound after cicatrisation, or that they had previously been deposited in the lymphatic glands and there had developed afresh. When reproduction of the disease takes place in this local manner, it is usually rapid within a few weeks, or at most, months, of the operation, and death is speedy from hæmorrhage, blood-contamination, and exhaustion.

2. *By Neighboring but not Local Reproduction.*—It would appear as if in some cases there was a tendency to epitheliomatous disease in a particular region of the body, which becomes more or less widely affected in different parts in a consecutive manner. Thus I have seen, after the removal of an epithelioma of the lip on one side, recurrence of the disease inside the mouth on the other side; or after the removal of an epithelioma on one side of the face, return of the disease in the cervical lymphatic glands on the opposite side. This method of recurrence is slower than the first. I have seen from three to four years elapse between the removal of the epithelioma on the left side of the lower lip and its recurrence inside the right cheek.

3. By *Distant Recurrence* either on the surface of the body or in internal organs. This distant recurrence is not, in my experience, so

common as the other methods. But I have seen, after removal of an epitheliomatous tongue, recurrence in one of the toes, and in the lung, after a lapse of nearly two years; and also deposits in internal organs as recurrences after removal of superficial epithelioma.

Adenoid Cancer. Columnar Epithelioma.—This form of cancer bears the same relation to the papilloma of the intestine that the squamous epithelioma does to a common wart or corn on the skin. It is confined to those regions which are naturally covered by columnar epithelium. It may come under the care of the Surgeon in the rectum, or, by causing obstruction of the sigmoid flexure or colon, it may call for the operation of colotomy. The tumor has a somewhat firm fleshy base, and is usually papillary on its surface. A section of such a growth (Fig. 315) shows it to be composed of tubes lined with columnar epi-

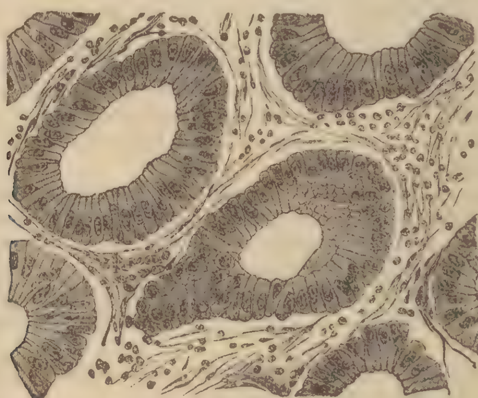


Fig. 315.—Columnar Epithelioma of transverse colon (188 diam.). One tube is cut obliquely, the others transversely; the epithelium is irregular in shape and size, and is sometimes arranged in more than one layer. The stroma is fibrous, containing small round cells.

thelium, bound together by a delicate connective tissue, more or less infiltrated with small round cells. The tubes resemble gigantic crypts of Lieberkühn. By the microscope alone it is not always easy to distinguish these tumors from simple papillomata covered with columnar epithelium, in which the bases of the papillæ on section give the appearance of tubes. The irregularity of the structure and the greater cell-infiltration of the connective tissue would lead to a suspicion of malignancy.

These tumors give rise to secondary growths in the glands, and sometimes even in the liver, in both of which situations they maintain their characteristic features, so that a tissue, looking like crypts of Lieberkühn irregularly massed together, may be found in the lymphatic glands or in the liver. In the lymphatic glands of the groin these tumors may break down and ulcerate, as in the case of common epithelioma. Except in the rectum, the diagnosis of this cancer is impossible on account of its seat, and it seldom occurs in such a situation as to admit of any treatment.

EXCISION OF TUMORS.

In describing the different forms of encysted tumor, the operative procedures necessary for their removal have been adverted to. We may

now conveniently consider the steps that are generally necessary for the extirpation by the knife of solid tumors from the soft parts.

In the removal of tumors, the first point to be attended to is the arrangement, shape, and direction of the necessary *incisions*. These should not only have reference to the size of the growth, extending well beyond it at each end, but must also be planned with due regard to subjacent parts of importance. As a general rule, they should be carried in the direction of the axis of the limb or part, and parallel to the course of its principal vessels; they must not only extend over the whole length of the tumor, but also a little beyond it at each end: no cross-cuts should be made if they can be avoided, and this may usually be done by attention to the proper position and extension of the linear incisions. In most cases, no skin should be removed, a simple cut being made; but if the integumental tissues be either very abundant and loose, or else adherent, an elliptical portion of them may be excised together with the tumor. In other instances, again, a semilunar flap of integument may with advantage be turned up from the tumor, the surface of which is then fairly exposed; this, however, can only be done in some simple tumors, such as fatty growths. The flaps covering the growth should then be freely but cautiously dissected back, so as to expose its sides and base; as these are approached, and the Surgeon reaches the neighborhood of its more important and deeper connections, increased care will be necessary, as it not unfrequently happens that the tumor is in more important relations with deep-seated blood-vessels and nerves of a large size than would at first appear.

When practicable, the *deep dissection* will best be commenced and carried out from that part of the base of the tumor into which the principal blood-vessels appear to enter; they are thus early cut, and being once ligatured give no further trouble, which they would do were they divided from the direction of their branches towards the trunk, when at each successive stroke of the knife a fresh portion of the vessel would be touched. In carrying on this deep dissection, the operator should proceed methodically from one side of the tumor to the other, the assistants holding aside the skin so as to give as much room as possible, whilst the Surgeon himself, seizing the mass with his left hand, or with a large double hook or vulsellum, and dragging it well forwards, uses the knife by successive strokes, but in a leisurely and careful manner, avoiding all undue haste, until he completely detaches it from its connections. The safety of contiguous important structures will be best secured by keeping the edge of the knife constantly directed towards the tumor, if this be non-malignant; by attention to this rule, I have seen Liston remove tumors with remarkable facility and ease from the neighborhood of most important parts. If, however, the growth be malignant, the incisions must be made wide of the disease into the healthy structures around; unless this be done, portions of the tumor may be left from which fresh growths will rapidly sprout, or cancer-cells may impregnate the neighboring tissues through which they are scattered, and may eventually become so many fresh centres of malignant action. After the tumor has been removed, it must be *carefully examined*, with the view of ascertaining whether it be entire; and, if any portions have been left, these must be properly dissected out. In some situations, as the axilla, the side of the neck, or the groin, where the relations are of great importance, the less the edge of the knife is used the better, and the growth should be enucleated by the Surgeon's fingers or by the handle of the scalpel.

The Surgeon should rarely undertake the removal of tumors that cannot be wholly and entirely extirpated, as the part left will always grow with greatly increased rapidity, often assuming a fungous character; this is especially the case with malignant tumors, the rapidity of increase of which is greatly augmented by partial operations. The exception to this rule consists in the case in which a large ulcerating and necrosing mass may be removed with the view of giving the patient temporary ease, and saving him from the annoyance of the putrescence of a disintegrating tumor.

Should, however, the Surgeon have begun the operation with the intention of removing the whole, and have been deceived as to the depth and connections of the mass, if, for instance, he find, after commencing his operation, that the tumor extends more deeply than had been anticipated, and comes into such close relation with important vessels, as at the summit of the axilla or in the perinæum, as to prevent him from dissecting it out without imminent risk of destroying the patient, the only alternative left is one that I have seen Liston adopt, and have had occasion myself to practise; viz., to throw a strong whip-cord ligature, above the apex of the growth as high up as practicable, and then to cut off everything below this. On the separation of the ligature, any portion of the tumor that has been included will be brought away as if it had been removed by the knife.

In some cases it will be found, after dividing the fascia covering the tumor, that the attachments of the growth are not so firm or deep as had been previously expected; this is especially the case in some large tumors springing from the side of the neck and the parotid region, or in the groin. The growth may then often be removed in a great measure by separating the areolar tissue with the handle of the knife, merely dividing those portions of the deeper attachments that are peculiarly dense.

The wound that is left after the removal of a tumor usually unites, partly by adhesive inflammation, and partly by the second intention; it should be lightly dressed, the edges being brought together by strips of plaster and covered by water-dressing, and if large, supported by a compress and bandage. If the cavity left be very deep, great advantage will be derived from the use of drainage-tubes, to prevent the accumulation of the discharges. Sutures should not be employed unless absolutely necessary; they irritate, and their removal is very painful.

The *elastic ligature* has of late years been employed for the strangulation of tumors. It is possible that such a means may be useful in certain small pedunculated growths, which dry on being strangled; but its application to large tumors, as of the breast, is simply a revival of mediæval barbarism with the aid of modern appliances. The slowness of its action, the pain as it cuts through, the large wound that is left, the fœtor from the necrosed tumor, and the chance of septic infection from this cause, all tend to make it a method that should be avoided whenever the knife can be employed. Far more tedious, and certainly not safer than the knife, it is also inferior to caustics, which at all events arrest putrefaction, and many of which, as chloride of zinc, have a powerful antiseptic action.

CHAPTER XXXV.

SCROFULA AND TUBERCLE.

These two diseases are intimately connected with certain morbid states of the lymphatic system, and have by many writers been considered merely as different expressions of the same constitutional state; they may, however, with greater propriety, be viewed as the results of a departure in different directions from the normal nutrition of the same system of elementary tissues. The two conditions are undoubtedly closely related in their causes and their effects, and may even co-exist in the same individual; still, in their most typical forms they present very marked differences, which serve to distinguish them clinically as well as pathologically.

Scrofula.—By this term is meant a peculiar constitutional condition, either hereditary or acquired, that gives rise to chronic inflammatory changes in certain tissues or organs, often accompanied by more or less swelling of the proximate lymphatic glands. The affections to which an individual so constituted is most subject, are catarrhal inflammations of the skin and mucous membranes, and subacute inflammations of the periosteal and synovial structures. The products of these inflammatory changes often undergo degeneration and obsolescence, giving rise to cheesy masses, which are not unfrequently confounded with those derived from true tubercle. The constitutional condition that tends to this is sufficiently characteristic; but, although we may recognize its existence, and speak of the individual possessing such a constitution as having a scrofulous tendency or diathesis, he can scarcely be considered to labor under the fully formed disease unless some of the above-mentioned changes having taken place in some of his tissues or organs.

Scrofulous Diathesis.—This is a peculiar constitutional state that is often erroneously confounded with general debility. It may, and often does, co-exist with this, but is by no means synonymous with weakness of constitution. Debility often exists without any scrofulous tendency or taint, more particularly in individuals of the nervous temperament; many delicate people, though weak, being perfectly healthy, and showing no disposition to this peculiar affection; on the contrary, the scrofulous constitution is often conjoined with much muscular power and mental activity. But though no weakness may be manifested in either of these respects, scrofula is invariably conjoined with debility or perversion of the nutritive activity of the body. This is especially manifested in certain tissues, such as the mucous and the cutaneous; and in those organs, the vitality of which is low, as the lymphatic glands, the bones, and the joints. In these, scrofula is especially apt to influence the products of nutrition and of inflammation, more particularly during the early periods of life, when these actions are most energetic, in such a way as to render its existence evident to the Surgeon. It is this tendency to the occurrence of particular diseases, and to the engrafting of special characters on affections of certain tissues, that may be considered as specially indicative of the existence of the scrofulous

diathesis; the existence of which is, moreover, marked by the presence of a peculiar temperament.

The **Scrofulous Temperament** assumes two distinct forms, the fair and the dark, and each of these presents two varieties, the fine and the coarse. The most common is that which occurs in persons with fair, soft, and transparent skin, having clear blue eyes with large pupils, light hair, tapering fingers, and fine white teeth; indeed, whose beauty is often great, especially in early life, being dependent rather on roundness of outline than on grace of form; and whose growth is rapid and precocious. In these individuals the affections are strong, and the procreative power considerable; the mental activity is also great, and is usually characterised by much delicacy and softness of feeling, and vivacity of intellect. Indeed, it would appear in such persons as these, that the nutritive, procreative, and mental powers are rapidly and energetically developed in early life, but become proportionately early exhausted. In another variety of the fair scrofulous temperament, we find a coarse skin, short and rounded features, light grey eyes, crisp and curling sandy hair, a short and somewhat ungainly stature, and clubbed fingers; but not uncommonly, as in the former variety, great and early mental activity, and occasionally much muscular strength.

In the dark form of the scrofulous temperament, we usually find a somewhat heavy, sullen, and forbidding appearance; a dark, coarse, sallow, or greasy-looking skin; short, thick, and harsh curly hair; a small stature, but often a powerful and strong-limbed frame, with a certain degree of torpor or languor of the mental faculties, though the powers of the intellect are sometimes remarkably developed. The other dark strumous temperament is characterised by clear dark eyes, fine hair, a sallow skin, and by mental and physical organization that closely resembles the first described variety of the fair strumous diathesis.

In all these varieties of temperament, the digestive organs will be found to be weak and irritable. This condition, which I believe to be invariably associated with struma, and the importance of which has been pointed out by Sir James Clark, must be regarded as one of the most essential conditions connected with scrofula, and as tending greatly to that impairment of nutrition which is so frequent in this state. This gastric irritability is especially characterised by the tongue, even in young children, being habitually coated towards the root with a thick white fur, through which elongated papillæ project, constituting the "pipped" or "strawberry" tongue; the edges and tip, as well as the lips, being usually of a bright red color. This state of the tongue is aggravated by stimulants, high living, and the habitual use of purgatives. In the fair varieties the bowels are usually somewhat loose, but in the dark forms of struma there is a torpid condition of the intestinal canal. In all cases the action of the heart is feeble, the blood is thin and watery, and there is a tendency to coldness, and often to clamminess of the extremities.

Strumous Inflammation.—One of the most marked characteristics of struma is certainly the peculiar modification that inflammation undergoes, whether we regard the course that it takes, the form that it assumes, its products, or its seat. The *course* of inflammation in strumous subjects is always slow, feeble, and ill-developed, the more active and sthenic conditions being rarely met with. In its *form* it is usually congestive, ulcerative, or suppurative; and in its *products* it is characterised by little tendency to adhesion, by the production of thin, blue,

weak, and ill-developed cicatrices, and by the formation of thin, curdy pus, with much shreddy corpuscular lymph.

The *seat* of strumous inflammation varies greatly; and peculiar modifications of course form, and products are assumed, according to the part that it affects. The tissues implicated by it are chiefly the skin and mucous membranes, the joints, and the bones, occasioning a great variety of special diseases, according as one or other of these structures are affected. It is as the result of, or in connection with, these local affections, that the general symptoms of struma become most marked. Whatever the variety of temperament may be, the individual usually emaciates, becomes sallow, cachectic, and debilitated, and at length falls into hectic or marasmus.

When affecting the *Skin*, scrofula declares itself under a variety of cutaneous eruptions, especially the different forms of eczema of the scalp, and various ulcers on the surface. usually weak, and largely granulating, with considerable swelling of the surrounding parts, and a tendency to the formation of thin blue and glazed cicatrices (Fig. 316). The integuments of the whole of the limb may become so much diseased in this way, œdematous, infiltrated, and covered by flabby ulcers and fistulæ, the extremity being perhaps double its natural size, that amputation is the sole resource.

Fig. 316.—Scrofulous Ulcer of Leg.

Fig. 317.—Scrofulous Disease of Arm and Finger.

The *Mucous Membranes* are commonly extensively affected, and often present the earlier forms of scrofulous disease in childhood; this is more especially the case with those of the eyelids and nose. The conjunctiva becomes chronically inflamed, perhaps with ulceration of the cornea. The mucous membrane of the eyelids may be permanently congested and irritated, with loss of lashes, constituting the different forms of psorophthalmia. The mucous membrane lining the nostrils becomes chronically congested, red, and swollen, giving rise to habitual sniffing of the nose, and to a sensation as of a constant cold. Occasionally that lining the antrum becomes irritated, and may then occasion an enlargement of this cavity, or the discharge of unhealthy pus into the nostrils. The tonsils are often found chronically enlarged and indurated, with occasional tendency to fresh inflammation; and the larynx may become the seat of various forms of congestion of its lining membrane, giving rise to aphonia. The state of the gastro-intestinal mucous membrane

has already been described when speaking of the state of the tongue; and that of the genito-urinary organs is also marked by a tendency to debility and irritation, indicated by discharges from the urethra induced by very slight exciting causes, and often very permanent. The occurrence of calculus of the bladder, especially in children, may also occasionally be attributed to the scrofulous diathesis.

Perhaps the most important local diseases arising under the influence of this agency, are those of the *Bones and Joints*. The bones are liable to the occurrence of various forms of caries and necrosis (Fig 317); more especially those bones that are spongy in their texture, as the short bones of the foot, and the articular ends of long bones. The joints are liable to that large class of affections that are commonly included under the term of *white swelling*, which consists of thickening, disorganisation, ulceration, and suppuration of the synovial membranes and cartilages.

Lastly, some of the *Glandular Organs* are peculiarly prone to scrofulous disease. Enlargement of the lymphatic glands, more particularly by the side of the neck and under the angles of the jaw, is of such frequent occurrence, and is usually so early a sign, that the Surgeon, in determining whether an individual is scrofulous or not, commonly passes his hand over the glands in this situation in order to ascertain their condition and size; these glandular enlargements are especially apt to run into unhealthy and chronic suppuration. The testes and the mammæ are occasionally affected; but other glandular structures, though sometimes implicated, are by no means so commonly found diseased as those that have just been mentioned.

TUBERCLE.—The occurrence of tubercle indicates a far greater departure from the normal nutrition of the part than is required for the production of scrofula. The typical constitutional temperament is that described at page 798 as the first scrofulous variety, but every degree will be found to exist between this and the coarser form. Tubercle more frequently affects the serous membranes and the internal organs, especially the areolar tissue entering into their structure, than scrofula does; whilst the skin and mucous membranes, which are commonly attacked by the latter, are rarely primarily invaded by the former.

Tubercle, though sufficiently well marked by its appearance and progress, cannot be looked upon as a specific affection, but must be considered to be a perverted or unhealthy development of the nutritive materials destined for the repair of the body and the restoration of the blood. According to Simon, it consists of a disease of the lymph, or nascent blood. It is a "dead concretion," a fibriniform product; insusceptible of development. "The scrofulous diathesis," says Simon, "consists in a peculiarity of blood-development, under which the nascent blood tends to molecular death by superoxydation." According to C. J. B. Williams, "Tubercle is a degraded condition of the nutritive material from which the old textures are renewed, and the new ones formed; and it differs from fibrine or coagulable lymph not in kind, but in degree of vitality and capacity of organisation.

It must, however, be viewed in the light of a new formation derived from the lymphatic elements of the connective tissue (Fig. 318); and it exhibits a constant tendency to affect the lymphatic system in every organ which it invades. It is essentially a lowly organised formation, tending rapidly to disintegration and dissolution. Recent experiments have confirmed the opinion formerly held, that it has not a specific origin: it may be produced in the lower animals by the introduction beneath the skin of irritating or putrid animal substances, and it will

very readily reproduce itself, both locally and in internal organs, when transferred from one animal to another.

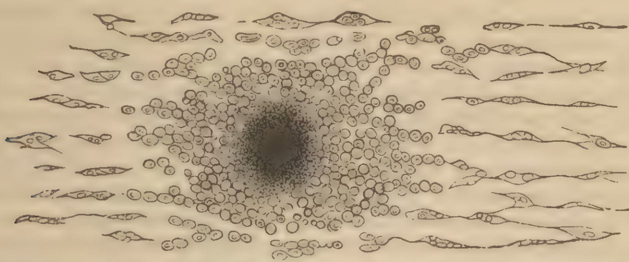


Fig. 318.—Diagram from Virchow, of Development of Tubercle from connective Tissue in the Pleura, showing Transition from Corpuscles of that Tissue up to the production of Tubercle Granules. The cells in the middle are undergoing fatty degeneration. 300 Diameters.

Structure.—Tubercle essentially occurs in two forms. It is met with as semi-transparent grey granulations, smooth, and cartilaginous in look, somewhat hard, closely adherent, and accumulated in groups, often with a good deal of inflammatory action in the surrounding tissues. These grey granulations, usually about the size of a small pin's head, appear to consist of modified exudation-matter. They have a tendency to run into masses, and to form the true yellow tubercle, which is met with in opaque, firm, but friable concretions of a dull whitish, or yellowish color, homogeneous in structure, and without any appearance of vascularity.

The microscopic characters of tubercle present no very specific appearances. The grey granulations or miliary tubercle consist mainly of a firm, reticulate stroma, in which are imbedded a number of cells and nuclei. These cells present two principal varieties, which measure respectively $\frac{1}{1200}$th to $\frac{1}{1500}$th of an inch in diameter: the larger ones contain two or three nuclei, which may sometimes be seen in the act of dividing; the smaller ones contain only a single nucleus. Many free nuclei, oval or spindle-shaped, also exist.

In the condition called crude yellow tubercle, multiple cells may be found at the circumference of the mass, whilst single nucleated cells occupy the centre: free nuclei are scattered abundantly amongst the cells. Both cells and nuclei present a remarkably shrivelled, irregular, and granular appearance, which was formerly considered as their great characteristic. The cells measure from $\frac{1}{2000}$th to $\frac{1}{3000}$th of an inch in diameter. In the softer forms of yellow tubercle the cells are more disintegrated, and drops of molecular oil and much granular matter are present. The fluid parts may subsequently become absorbed, and leave a cheesy or cretaceous mass. Tubercle must often be recognized rather by its negative than by its positive characters—by ascertaining what it is not, and so, by a process of exclusion, arriving at its true nature. It is most easily confounded with pus, from which, however, it may be distinguished by its possessing a solid inter-cellular substance.

The *Progress* of tubercle is most commonly to disintegration and liquefaction, at the same time that it gives rise, by its irritation, to inflammation and suppuration in the surrounding tissues; hence it commonly leads to abscesses, the pus of which is always curdy and shreddy. In some cases tubercle may become indurated, and undergo a species of calcification.

Causes.—The causes of scrofula and tubercle, unless these be of a

hereditary character, though very various in their nature, are usually such conditions as influence injuriously the nutrition of the body.

The **Hereditary Nature** of both scrofula and tubercle is well known to the public and to the profession; for, although the disease is not commonly connate, yet the tendency to it is, and the characteristic nature of the affection often manifests itself at an early period, notwithstanding every effort to prevent its development. That a parent may transmit a tendency to malnutrition, to misdevelopment of the blood, just as he may a peculiar feature or mental condition, is undoubted. It is by the hereditary transmission of peculiar combinations and modifications of action in the organisation that hereditary diseases develop themselves at certain periods in the life of the offspring when the injurious results of the morbid actions that have been transmitted have had time to be produced. There are certain conditions which, though not scrofulous, are supposed to have a tendency to develop this disease in the offspring to which they are transmitted; thus very dyspeptic parents commonly have strumous children; so, also, the offspring of very old or very young people often exhibit a proneness to scrofulous or tuberculous affections. The influence of intermarriage is still a matter of doubt, but I believe that it is but small; and it is commonly stated that the inhabitants of small communities who intermarry closely, such as those of the Isles of Portland and of Man, are not more liable to scrofula than other individuals.

The most powerful occasioning cause of scrofula, and that which in most civilised countries is likewise the most frequent, is *malnutrition* and *malassimilation* arising from an habitual disregard of hygienic laws; either from want of food, or the administration of improper food in the poorer classes; or from overfeeding, and overstimulation of the digestive organs, amongst the children of the wealthier orders of society, inducing chronic irritation of the mucous membrane of the stomach and interference with the digestive powers, and consequently with nutrition. The influence of food that is innutritious in quality or insufficient in quantity, has been shown by Phillips, in his excellent *Treatise on Scrofula*, to be the most immediate cause of this disease; and, when conjoined with the injurious effects of a confined and impure atmosphere, it may be considered as sufficient to occasion the disease in those cases in which no predisposition to it exists, and gradually to develop any hereditary tendency to it in the system. It is to the conjoined influence of agencies such as these, that we must attribute the prevalence of scrofula amongst the lower orders both of town and of rural populations.

The *inoculability*, *infection* and *transmission* of tubercle are questions of the deepest interest in a pathological point of view. Their full consideration would lead far beyond the limits of such a work as this. It is sufficient to say that the experiments of Villermin, Wilson Fox, and Burdon Sanderson have fully established the inoculability of tubercle. The infection of the system from old caseous tuberculous deposits, more especially in bones, if not actually proved, is in the highest degree probable. And there is strong evidence in support of the belief of its transmission from individual to individual by close cohabitation, social or sexual.

The practical bearings of these pathological facts and views are obvious in their application to the hygienic prevention of tuberculosis, and the importance of the removal by operation of all old tuberculous masses in glands or bones, lest they become centres of tuberculous dissemination.

Both scrofulous and tuberculous manifestations are often called into immediate action by the *debility induced by previous diseases*, such as measles, scarlatina, hooping-cough, &c., which lead to an overaction of the lymphatic system, resulting in an active hyperplasia of the gland elements. The former usually develops itself at *an early age*, though seldom before the child has reached its second year It is most commonly about the period of the second dentition that the affection declares itself, and it is rare to meet with it for the first time after the ages of twenty-five or thirty-five. According to Phillips, when it is fatal, it usually proves so before the fifteenth year; 60 to 70 per cent. of the deaths occurring before this age. *Sex* does not appear materially to influence the disease; though, according to the same authority, the deaths of males from scrofula exceed those of females, in this country, by 24 per cent. These numbers may, however, require correction if we are to regard phthisis as an affection dependent upon the existence of either of these conditions, people who are scrofulous in early life, often becoming the subjects of that form of phthisis now called scrofulous pneumonia.

Treatment.—This should rather consist in endeavoring to prevent the occurrence or full manifestation of scrofula, than in removing it when it is actually existing. Indeed, the **Preventive Treatment** is perhaps of most consequence, and by proper attention to it, I have no hesitation in saying, the development of the affection, even when hereditary, may be stopped; and the child of strumous parents, presenting perhaps the features indicative of the diathesis, may pass through life without the disease having an opportunity of declaring itself. In order to accomplish this, however, the preventive plan of treatment must be commenced early, and continued uninterruptedly for a considerable time, even for years.

The preventive treatment of scrofula and tubercle may be said in general terms to consist in close and continuous attention to hygienic rules. The diet must be specially attended to; nourishing food, but of the lightest quality, being given. A great error is often committed in overloading the stomach with more or with heavier food than it can digest, under the impression that strong food is necessary to give the patient strength. In consequence of this error, the irritability of the mucous membrane is kept up, nutrition is imperfectly and badly performed, surplus food is thrown off in the shape of lithates or other products of malassimilation, and health and strength, which are the results of perfect nutrition, become impaired rather than improved. The use of stimulants, whether wine or beer, should be very sparing, and the milder and weaker should be preferred to the heavier and stronger kinds of malt liquor; the bowels must be kept regular with the simplest aperients; the clothing should be warm, and must cover the whole of the surface; and the patient should, if possible, be kept in well-ventilated rooms. He should be allowed sufficient exercise in the open air, not carried to the point of fatigue, and should, if his circumstances will permit, have change of air from time to time, alternating a sea with an inland climate. Bathing also, whether in sea or river, with the habitual use of the tepid or cold sponge-bath, and friction of the surface with horse-hair gloves or a rough towel, so as to keep the skin in healthy action and its cutaneous circulation free, should be regularly practised. In carrying out this general plan of treatment, it must be borne in mind that the health and strength of a delicate and weakly child can only be improved up to the highest standard admissible by its individual constitution. A weakly scrofulous child may be improved in health and

may be strengthened in body; but it can never, by any hygienic, dietetic, or medicinal process, have the original defect in the organisation so completely eradicated as to be rendered robust and vigorous, as would be a child of good congenital stamina who had been equally well cared for.

The **Curative Treatment** should be specially directed, like the preventive, to the general improvement of the nutrition, and through it to the augmentation of the constitutional vigor of the patient; all those hygienic means that have just been alluded to being continuously carried out.

The more strictly medical treatment of scrofula consists in the administration of tonics and alteratives with the view of improving the patient's constitutional powers. Before they are administered, however, it is always necessary to see that the digestive organs are in a healthy condition. Scrofula is a consequence of malnutrition; and unless we see that digestion, the first stage of the nutritive process, is properly accomplished, all other means will be useless. When the tongue is covered with a white, thick, creamy fur, and has elongated papillæ and red edges, the mucous membrane being in a state partly of irritability and partly of debility, neither purgatives nor tonics can be largely administered: the former irritating, the latter overstimulating the morbidly sensitive mucous membrane. In these circumstances the patient should be confined to the mildest possible diet, which must principally consist of milk, boiled fish, white meats, and light pudding, no stimulant of any kind being allowed except a small quantity of claret or bitter beer; and, unless the patient have been accustomed to the use of stimulants, these even had better be dispensed with. Small doses of mercury with chalk, of soda and rhubarb, should be occasionally administered at bed-time, with some of the compound decoction of aloes on the following morning; and a few grains of the carbonate of soda or of potash may be given twice or thrice a day in some light bitter infusion, as of cascarilla or calumba. In many cases of strumous disease, more especially those affecting the joints and bones, the liver will be found to be enlarged and sluggish in its action, the patient every now and then becoming bilious, sallow, and jaundiced; in these circumstances, small doses of blue pill, carried off with the compound decoction of aloes or a rhubarb draught, will be found necessary from time to time. When all gastric irritation has been removed in this way, or if it have not existed in the usual marked degree from the first, the patient being pale and flabby, with a weakened condition of the pulse, of the skin, and of the mucous surface, then tonics may be administered, and the more specific treatment adopted.

The great remedies which are employed with the view of removing scrofula and curing the secondary affections which it induces, are iron, iodine, the preparations of potash, and cod-liver oil. These are all extremely useful, either singly or conjoined, as they serve to carry out distinct indications in the management of this affection.

Iron is most useful in improving the nutrition of pale flabby anæmic subjects, increasing markedly the quantity and quality of blood in the system. The best preparations for children are, I think, the vinum ferri and the syrup of the iodide of iron. In older persons the tincture of the perchloride, and some of the forms of the citrate or the phosphate of iron, appear to be most serviceable; in other cases, again, the natural chalybeate waters will be found to agree best.

Iodine is especially valuable in promoting the absorption of effused plastic matters, and in lessening the morbid hypertrophies which so

commonly take place in scrofula. The preparation usually employed is the iodide of potassium. In order that this may produce its full effects, it should be given as freely as the patient will bear it, continued for a considerable length of time, and especially administered in combinations with other preparations of potash. With the view of preventing it from irritating the stomach, it should be given in a considerable quantity of some bland fluid. Its combination with the other salts renders it more efficacious in removing strumous enlargements and deposits of aplastic and tuberculous matter. For this purpose I have found the following form extremely useful for adults, the dose being proportionately diminished in the case of children:—℞ Potassii iodidi, Potassæ chloratis, āā ʒj; Potassæ bicarbonatis, ʒiij. Divide into twelve powders, of which one is to be taken night and morning in half a pint of warm milk. In other cases, the liquor potassæ, Brandish's alkaline solution, or lime-water given freely in milk, are serviceable; but I prefer the above prescription.

Cod liver oil, which may be looked upon rather as an article of diet than as a medicine, is of essential utility in improving the nutrition of the body in cachectic and emaciated states of the system, more particularly in growing children, or in individuals who are suffering from the wasting effects of strumous suppuration; it not only fattens but strengthens the system, increasing decidedly the muscular power and the quantity of red corpuscles in the blood. It may often very advantageously be administered in combination with the iodides of potassium or iron, and given after meals.

Of the other tonic remedies which may be employed in this affection, such as the preparation of *bark*, and of *sarsaparilla*, I need say nothing beyond that they may be usefully administered in fulfilling ordinary therapeutic indications. Ringer has lately recommended the *sulphide of calcium* as extremely valuable in scrofulous and tuberculous glands, and in chronic strumous sores and abscesses. He uses it in a solution which has much the strength of Harrogate Waters. Thus, he directs a grain of the sulphide of calcium to be dissolved in a half pint of water, and of this a teaspoonful is taken every hour. Under its influence, the glands, it is said, either return to the normal state or hasten on to suppuration, and chronic abscesses either dry up or are speedily brought forward and their contents discharged, a healthy healing sore being left.

The **Local Treatment** of scrofula consists in a great measure in the ordinary local management of chronic inflammation, modified according to the seat and peculiar nature of the affection. Much of the local treatment, however, especially in the more advanced stages, consists in removing the effects of the disease in the shape of aplastic deposits, false hypertrophies, and general enlargement and thickening of parts. This may usually be done by the application of lotions containing the iodide of potassium, or the carbonate of potash, applied by means of lint covered with oiled silk; a drachm of each of the salts, with an ounce of spirits of wine to eleven ounces of water, makes an excellent application, which appears to dissolve away the fibrinous and plastic deposits common in this disease. In many cases, frictions with the iodide of lead ointment, or pressure by means of strapping and bandages, will be found the most serviceable means that the Surgeon can adopt. When matter forms, it should be let out in accordance with the rules laid down in treating of the more chronic forms of abscess. In these cases, the injection of the sac of the abscess with a solution of iodine will be found very useful.

Operations in Scrofulous and Tuberculous Cases.—In cases of scrofulous diseases of the soft parts, the bones, or the joints, the question of the propriety of operating, whether this be for the excision of a gland, the resection of a joint or bone, or the amputation of a limb, has often been discussed. In these cases, operations should not be undertaken too hastily, too early in the disease, or in very young subjects. The affection being constitutional, it will often be found, as the general health of the patient is improved by proper treatment, that local mischief, which at first appeared very intractable, gradually assumes a more circumscribed and healthy form, and, in fact, to a great extent undergoes spontaneous cure by the restoration of the healthy action in the parts. This we especially find to be the case in young children, in whom very extensive disease of the bones and joints may often be recovered from, without the necessity of any serious surgical interference. Should any operation be undertaken, it is desirable not to have recourse to it whilst the disease is actively spreading. In these circumstances, it is not only probable that suppurative inflammation of an unhealthy kind may be set up in the wound itself, but that disease of the soft parts or bones may recur in the cicatrix of the original wound, or that the corresponding parts on the opposite side of the body may become similarly affected in very chronic cases of scrofulous disease of bones and joints. After excision of the elbow, the knee, or the bones of the foot and wrist, the morbid action will sometimes return in the contiguous soft parts to such an extent as to render a second operation necessary, although the bones were not implicated; the tissues in the neighborhood of the cicatrix becoming swollen, spongy, and infiltrated with a quantity of gelatinous semi-transparent plastic matter, running into unhealthy suppuration, with fistulous tracts leading through it that cannot be brought to heal. In some cases even of simple strumous disease of the integuments of the arm, leg, or foot, attended with great and irregular deposition of plastic matter, and chronic and intractable ulceration, amputation of the limb is the only course left to the Surgeon. When strumous suppuration leads to hectic, the patient will speedily sink unless the diseased structures be removed.

CHAPTER XXXVI.

VENEREAL DISEASES.

THE term *Venereal Disease* is used to denote those affections which arise primarily from sexual intercourse. It was, until lately, held to include two distinct specific diseases—Syphilis and Gonorrhœa. The special researches of Surgeons in this country and on the continent have, however, in late years, apparently established the fact, that in the term Syphilis there have been included two distinct affections, both communicable by contagion during intercourse, but differing in their characters, and especially in this,—that the one is a purely local affection, while the other not only produces local effects, but, by the introduction of a specific poison into the system, infects the general constitution of the person to whom it is communicated. To the purely local disease the term Local Contagious Ulcer or Chancre may be applied; the word Syphilis being restricted to the constitutional affection.

Hunter and his followers supposed that all the specific diseases arising from sexual intercourse originated from one and the same poison. But this doctrine has been proved to be erroneous; for not only are the local appearances and constitutional effects of these diseases widely different, but Ricord has shown, in the most conclusive manner, that gonorrhœal matter, when inoculated on the skin or mucous membrane, never produces a chancre; and that, on the other hand, chancrous pus can never be made to produce gonorrhœa. Each of the diseases—Local Contagious Chancre, Syphilis, and Gonorrhœa—propagates itself, and no other. Two of these diseases may, however, co-exist in the same person. Thus, we shall have occasion to notice the coincidence, in some cases, of the local chancre with the phenomena of constitutional syphilis. Again, Ricord has pointed out, that a woman may at the same time be affected by gonorrhœa and by chancres on the uterus; and this probably explains those cases in which, after connection with the same woman, different men have contracted different forms of disease, or even both affections. In this Chapter, we shall describe—1, the Local Contagious Ulcer or Chancre; 2, Syphilis, or Constitutional Syphilis; reserving the consideration of Gonorrhœa till we speak of Diseases of the Urinary Organs.

I.—LOCAL CONTAGIOUS ULCER OR CHANCRE.

The **Local Contagious Ulcer or Chancre** is a sore of special form and appearance, characteristic of the nature of the disease. It may occur on the cutaneous, the muco-cutaneous, and mucous surfaces, most commonly on the latter, on account partly of their greater exposure to contagion, but chiefly from their being less perfectly protected by epidermis. Chancres present much variety as to their appearance and to the course which they pursue: so great indeed are the varieties, that they have been looked upon by some Surgeons as affording evidence of distinct diseases proceeding from different poisons. This doctrine, however, is entirely erroneous; the varieties in their appearance depend on seat, constitution, and other accidental circumstances. A chancre, then, is a specific venereal sore or ulcer, originating invariably from contagion, and capable of propagation to other parts of the same or of different individuals by inoculation. Like all other ulcers, a chancre presents two distinct periods: the first, in which it is either spreading or stationary, in which alone it is specific, and which may be of almost indefinite duration; and the second, in which it has commenced to granulate, and a process of repair is set up in it.[1]

Specific Nature.—Ricord has made the important observation that, if the pus from a chancre, during its first period, be inoculated into any part of the surface of the body, it will invariably produce another specific venereal sore or chancre; and that no pus that is not chancrous can, under any circumstances, occasion the specific venereal ulcer. This inoculable ulcer is always in its effects a local disease, being confined to a specific sore; of which the furthest complications are repetition of the sore wherever its discharge invades an unprotected surface, and the occasional irritation of the neighboring lymphatic glands to inflammation and abscess.

Origin and Progress.—A chancre is necessarily generally contracted in impure sexual intercourse with a person already contaminated by the

[1] The term Chancre is also applied to the ulcer which is the primary manifestation of constitutional syphilis. This chancre, which presents distinctive characters, will be found described at page 822.

disease, by the direct contact of the healthy with a previously diseased surface. When a chancre is caught in connection, it usually commences with a small excoriation, which appears to have been directly inoculated with the specific poison. In other cases, though more rarely, it may be seen at first in the shape of a small pointed pustule, which speedily breaks, leaving an ulcer of a specific character in its site. Very generally, however, this pustule escapes observation, and the disease is presented in the first instance as an ulcer. The chancrous ulcer, whatever form it assumes, seldom makes its appearance until a few days (five or six) after connection. In some cases, however, I have observed it, evidently from the infection of a fissure or crack, on the day following impure intercourse; and occasionally, in rare instances, its appearance may be delayed a few days longer than that time which has been mentioned.

Chancres are occasionally contracted in various irregular ways. Thus they may occur on the fingers of Surgeons or accoucheurs from dressing venereal sores, or from attending diseased women during labor. In these instances, however, the consequences of contagion are nearly always of another kind; namely, the inoculation of constitutional syphilis, not the merely local ulcer. In other cases, the disorder is contracted from the contact of filthy clothes or dirty utensils with the person; and not uncommonly, it is said, chancres are contracted in public water-closets. Although the latter mode of infection is not impossible, it should be received with doubt, as it is an explanation not uncommonly adopted by those who desire to account for the consequences of an act of immorality, in a way that does not expose them to reproof. In speaking of these modes of propagation of syphilis, Wiseman says: "It is frequent to mention other secondary ways of the propagation of it; as lying in the same bed with an infected person, lying in the same sheets after them, or wearing their cloaths. . . . Drinking with one so affected, or sitting on the close-stool after them, are likewise mentioned among the causes of infection These are all such convenient excuses for the more shie and coy patients, that it is a pity to discountenance them" (Wiseman: "Several Chirurgical Treatises of Lues Venerea," London, 1676).

Whatever be the appearance presented by a chancre, there can no longer be any doubt that the disease arises from one kind of virus only; the modifications in the sore depending on its situation, on the constitution of the patient, and occasionally on that of the individual who communicates the infection. That this is so, is evident from the facts that every chancre, when inoculated, reverts to one typical form; and that, however much chancres may ultimately differ, they all present the same characters during their early stages.

The progress of a chancre that has been artificially inoculated on any part of the cutaneous surface is as follows, and its study will serve to elucidate what takes place in other circumstances. During the first twenty-four hours after the introduction of the specific pus into the skin on the point of a lancet, we find that some inflammation is set up around the puncture, which becomes hot, red, and itchy. About the third or fourth day, a pointed pustule is produced, which is at first deep-set, but becomes on the following day more superficial, with some depression in the centre, resembling rather closely a small-pox pustule; on close examination, this will be found not to be a true pustule, but rather a mass of epithelial scales and pus not included in the distinct wall. On the fifth day, it has become hard at the base, apparently from the infiltra-

tion of plastic matter; and on the sixth it has usually dried, forming a small round scab, and leaving an ulcer which presents the typical characters of a true chancre, being circular and depressed, with a foul greyish surface which cannot be cleansed, sharp-cut edges, a base more or less indurated by inflammation, and an angry-looking red areolar around it. This is the typical chancre, and these are the appearances that every true venereal non-syphilitic sore on the skin will present about the fifth or sixth day after inoculation; from this time it may diverge more or less completely from these characters, but will yet, if inoculated at any time during the poisonous stage, produce an ulcer that will run the specific course up to the same period, after which it may in its turn again deviate into one or other of the unusual forms that chancres occasionally assume.

Varieties.—These have been described under various denominations by the numerous writers on these affections. The following classification will include them all:—1, the Simple or Soft Chancre, or Chancrous Excoriation; 2, the Phagedænic Chancre; and 3, the Sloughing Chancre. As H. Lee has observed, each of these varieties of chancres is associated with a particular variety of inflammatory action. Thus the *soft* is the *suppurative* form; the *phagedænic*, the *ulcerative;* and the *sloughing*, the *gangrenous*. The particular form of the sore is in each case determined by its situation, and the constitution of the patient or that of the individual furnishing the contagion.

1. **Simple or Soft Chancre**, or **Chancrous Excoriation**, is certainly that form of the disease which is most commonly met with in London at present, from its excessively contagious character. It consists of one or more small sores, of a very shallow character, resembling rather an abrasion, with sharp-cut edges, somewhat circular in shape, and having a tawny greyish or yellowish surface, with a narrow red areola around the edge: in many cases attended with much heat and itching. These sores are usually seated on the cleft under the corona glandis, or about the glans, the whole of which may be studded by them. In fact, one peculiarity of this chancre is its tendency to multiplication on the contiguous structures. In other cases, the sores invade the frænum, which may be perforated; or they may occupy the mucous surface of the prepuce. In no case are they indurated.

The excoriated chancres not unfrequently present somewhat varying appearances. In some cases their surfaces become covered with large fungous granulations, hence termed *fungating sores.* In other instances they are truly irritable, becoming exceedingly sensitive, with a tendency to spread, and having a dusky red areola around them. These chancres are very frequently attended by much general inflammation of the penis; the organ being swollen, red, and semi-transparent, from subcutaneous œdema, and usually in a state of phimosis, with much purulent secretion between the prepuce and glans.

2. **Phagedænic Chancre** is characterised by a tendency to erosion, with much destruction of the parts that it invades. It may assume the phagedænic character from the very first, or this may be set up in one of the other varieties of chancre at some period of their course. The progress of this phagedænic or eroding chancre is usually somewhat slow, but continuous; it commonly affects the glans, more especially in the neighborhood of the frænum or urethra, destroying a considerable portion of the organ in this situation. Wallace has divided this form of chancre into three varieties; that *without slough*, that *with white slough*, and that *with black slough.* Each of these varieties, again, may be of

a *simple*, an *inflamed*, or an *irritable* character. This classification appears to me to be an useful and practical one, and I accordingly adopt it.

The *phagedænic chancre without slough* is a truly eroding ulcer, spreading with sharply cut edges, attended by some slight inflammatory action, and with much activity of progress; it is commonly observed about the frænum and under part of the glans, and very frequently hollows out and destroys the organ in this situation to a considerable extent.

In the *phagedænic chancre with white slough*, we find an irregular eroding ulcer, with a thin margin of white slough situated at the junction of the dead and living structures; that which covers the surface of the sore having usually become darkened by exposure to air, to dressings, and to secretions.

The *phagedænic chancre with black slough* differs but little from the last, except in the color of the slough, which may be in a great measure accidental, and in its tendency to induration, and to somewhat rapid extension; it must not be confounded with the next form of chancre, which presents many points of difference. All these varieties of phagedænic chancre may be inflamed, being attended with much heat, redness, and swelling, increase of discharge, and rapidity of action; or they may be irritable, occurring in cachectic individuals, when they are accompanied by much pain, and usually a good deal of constitutional disturbance of a nervous and irritable type.

3. **Sloughing Chancre**, or **Gangrenous Phagedæna**, is a combination of rapidly spreading and destructive gangrene with the venereal poison, and may be looked upon as a gangrenous inflammation of a venereal sore.

The gangrene is usually the consequence of the confinement of the venereal pus under an elongated prepuce, in a person of inflammatory and irritable constitution, in whom the loose areolar tissue of the genital organs readily takes on sloughing action when inflamed. It usually affects the upper surface of the prepuce. The parts becoming immensely swollen, red, and somewhat brawny, and the prepuce being in a state of complete and permanent phimosis, a dusky black-looking spot soon makes its appearance on one side of the organ; this rapidly extends, giving rise to thick, black, soft, and pultaceous sloughs, destroying perhaps the whole of the prepuce, and exposing and implicating the glans to a great extent, accompanied sometimes by copious hæmorrhage from the dorsal artery of the penis on the separation of the sloughs, and by denudation of the corpora cavernosa. In other cases, the prepuce sloughs on one side only; a round aperture forming in it, through which the glans projects, whilst the swollen and inflamed extremity of the prepuce hangs down behind it, giving the organ a very remarkable, and at first sight, somewhat puzzling appearance. After the separation of the sloughs, granulations rapidly springing up, the sore loses its specific character, and cicatrisation advances with rapidity.

Situation.—As chancres almost invariable result from connection with persons suffering from sores of a similar nature, they commonly occur on the genital organs. In the *male* they may be met with in any part of these; their characters vary somewhat, however, according to the situation in which they occur. They are by far most commonly seated in the angle formed between the glans and the prepuce; they then appear most frequently at the orifice or on the inner surface of the prepuce, next on the frænum, then on the glans, and lastly at the orifice of

the urethra, or on the skin of the body of the penis. Those about the frænum are often sloughy and irritable, have a great tendency to perforate or destroy this membrane, and are more frequently followed by hæmorrhage or bubo than any of the other varieties of the disease.

The **Urethral Chancre** is usually situated just within the orifice of the canal, and may be seen on pressing open its lips, in the form of a small sloughy sore, which occasionally creeps out upon the glans. Sometimes it is more deeply seated, so as to be out of sight; when this is the case, a thick, tenacious, sloughy and bloody discharge appears in small quantities from the urethra; at a little distance up the canal there will usually be felt, on grasping the organ between the fingers, a circumscribed indurated spot, which is somewhat painful on pressure and after micturition. The chancres have been found by Ricord to extend along the whole of the urethra, even to the bladder; and it is their presence in this canal that formerly led to the supposition of the identity of syphilis and gonorrhœa, an error which has been disproved by the test of inoculation; the discharge from urethral chancre producing the typical sore, that from gonorrhœa giving no result when introduced under the skin. The existence of chancre within the urethra may be suspected if the urethral discharge be small in quantity, and somewhat dark colored, ichorous, and sloughy in appearance. The chancre may be detected by everting the edges of the urethra, or, if situated too high up the canal to be seen, by being felt hard and nodulated through its coats.

Chancres may also form on other parts where they have been accidentally or purposely inoculated. Thus I saw many years ago (1839) in Ricord's wards, a man, laboring under *eczema of the legs*, in whom the cutaneous disease had been converted into a series of immense chancres by accidental inoculation from a sore on the penis.

In **women**, chancres are usually situated on the external organs of generation, most usually just outside the fourchette or labia minora, very rarely indeed on the lining membrane of the vagina, but sometimes on the cervex or os uteri; hence it is impossible ever to pronounce a woman free from chancre without examining these parts by means of the speculum. When situated upon the external organs, they are not unfrequently concealed between the rugæ, or in nooks and corners of the mucous membrane. In these cases, their presence may sometimes be detected by the labia being swollen and œdematous from the irritation produced by them.

Diagnosis.—The diagnosis of chancre is usually sufficiently easy, the peculiar character of the sore enabling the Surgeon to recognize it in all its forms. In some instances, however, it is by no means easy to say positively whether an ulcer on the penis be or be not chancrous. It is especially difficult to distinguish some forms of excoriated chancre from herpes or aphthæ on the prepuce or glans, or from those slight excoriations that many men habitually contract after a somewhat impure connection; so, also, the wound resulting from a ruptured frænum often presents a suspicious appearance. In these cases, however, the absence of any specific character about the sore, its immediate occurrence after connection, the general known tendency of the patient to these affections, and the fact of the inguinal glands not being generally indolently enlarged, will enable the Surgeon to diagnose the ulcer to be simply a local affection, and not the prelude to general syphilitic eruptions. When the prepuce is in a state of inflammatory phimosis, it is always extremely difficult to determine by mere examination whether there be chancres under it or not, though their bases indurated by inflammation may some-

times be felt through it. In the case of the phagedænic or the sloughy chancre, there can be little difficulty in establishing the true nature of the affection. In those cases in which a comparison of the characters of the sore with one or other of the different recognised varieties of chancre failed in enabling the Surgeon to determine the true nature of the affection, it was thought at one time, when the local contagious ulcer and the phenomena attending the progress of syphilis were confounded together, that the influence exercised by mercury upon the sore would determine whether the disease were syphilitic or not; the true chancres being supposed to be curable in no other way than by the internal administration of mercury; but, although there can be no doubt that the influence exercised by treatment assists the Surgeon considerably in the diagnosis of obscure cases, yet it cannot be relied upon as a test of the nature of the disease, many venereal affections being readily curable by very simple means without mercury. It must be further recollected, that little practical advantage is gained by experimenting on the contagious quality of the discharge; because, if the patient have been exposed to syphilitic contagion, when the sore comes under the observation of the Surgeon it will be impossible to prevent his infection, which will have taken place in a very few hours after the application of the poison.

Treatment of Chancre.—The treatment of venereal sores has engaged the anxious attention of the most eminent Surgeons; and so much difference of opinion and practice regarding it still prevails, that I shall not endeavor to discuss the subject generally, but rather confine my remarks upon it to that form of treatment which has met with the sanction of the best Surgeons in this country, and which a tolerably extensive experience in hospital and private practice has led me to consider as the most safe and effectual.

The treatment of chancre is of a *local* and of a *constitutional* character. The local treatment has for its object either to destroy the poisonous character of the sore, or to modify it so as to bring it into the state of a healthy ulcer; the constitutional treatment is not only intended to facilitate this, but to prevent, if possible, infection of the general system with the poison of constitutional syphilis, should this have been communicated with the local disease.

Local Treatment.—This has for its object either the destruction or the modification of the specific character of the sore. The complete destruction of the local virus should always, if possible, be effected; and if this can be done in the early stage of the disease, the healing of the sore will be much expedited. But, even though considerable time have passed before the Surgeon sees the sore, it is well to destroy the ulcerating and poisonous surface, that its further extension may be prevented. This should be effected by the application of caustics in a sufficiently concentrated form to destroy radically and at once the specific character of the sore, so as not only to save the pain, but to prevent the irritation attendant upon frequent applications. The nitrate of silver, which is frequently used for this purpose, is too weak to secure the effect it is intended to accomplish, being apt to irritate and inflame, and not to destroy the chancrous surface, thus necessitating repeated and painful applications. I consequently prefer to this the strong nitric acid, one application of which will very commonly suffice to annihilate the specific character of the sore: though more energetic in action, it does not give rise to more pain than the nitrate of silver. It should be applied by means of a piece of wool, a glass rod, or a small dossil of lint wrapped round the end of a silver probe; with this the sore may be freely mopped,

and then, a stream of cold water having been poured over it to wash away any superfluous acid, a light poultice or a piece of water-dressing should be laid on; after the small slough produced by the caustic has separated, a healthy granulating surface will be left. The caustic may be applied at any time during the continuance of the specific condition of the sore; but when once this has been destroyed, it should not be re-applied. The potassa fusa and the potassa cum calce, though occasionally used, are far less manageable and not more efficacious applications than the nitric acid.

With the view of modifying the specific character of the sore, there is no application so efficacious as *iodoform*. A small quantity should be dusted on every day, and the sore dressed dry with cotton-wool. It is most efficacious, and will often cure a soft chancre in a week or ten days.

These are the means that are generally most useful in *Simple Chancres*. In some cases, however, inflammation of the sore, or peculiarities in its situation, demand modifications of the treatment.

If there be much inflammation about the sore and prepuce, this must first be subdued by the application of cold poultices, or of lead and spirit lotion. When this is removed, if the sore have not lost its specific character, the caustic should be applied in the usual way.

Should there be phimosis with discharge of chancrous pus from under the tightened prepuce, it will be better to slit this up, so as to expose and freely cauterise the subjacent chancres. If the cut edges of the prepuce become inoculated, they must also be cauterised freely and early.

If the chancres be situated round the orifice of an elongated and tight prepuce, circumcision is the best means of removing the disease and the inconvenience at the same time. The cut surface, however, will always become infected, and requires to be freely cauterised by nitric acid.

After the slough produced by the caustic has separated, the surface may begin to granulate healthily at once, requiring but simple dressings; but in the majority of cases it will continue in a somewhat unhealthy condition, demanding special topical applications to cause it to cicatrise soundly. If it be weak and fungating, an astringent lotion, such as the following, will be found more useful:—℞ Tannin, gra. xx; Tinct. lavandulæ comp. ʒij; Vini rubri, ℥iv. Ft. lotio. Or a solution of sulphate of copper may be applied, and the sore touched from time to time with nitrate of silver. If there be induration at its base, the black or yellow wash will perhaps be found the best application that can be used.

When the chancre is indurated by syphilis, no attempt should be made to burn the indurated base with caustic, as it will prove unsuccessful, the cause of the induration being always beyond the influence of the caustic. In these cases, the best local application is generally the black wash.

In the **Phagedænic Chancre** a different management is required. If there be much irritability about the sore, the nitric acid cannot be borne; and here the best application is an opiate lotion, conjoined perhaps with small quantities of the chloride of soda. If the part require more stimulation, a few drops of the dilute nitric acid may advantageously be added instead of the chloride. In these cases, however, the application of the strong nitric acid may often be required at a later period, on the removal of the local irritation by the topical employment of sedatives. In many cases, the local inflammatory action is best removed at first by the application of the concentrated nitric acid, this

being followed by opiate lotions or emollient poultices, and the caustic being reapplied whenever there is a tendency to extension of the disease.

In **Sloughing Chancre,** when the prepuce is greatly tumefied, in a state of inflammatory phimosis, and of a deep red or purplish color, with threatening of extensive gangrenous action, a director should be passed between it and the glans penis, and the swollen prepuce slit up. In this way tension is removed, and the extension of the sloughing action arrested. Any chancre that is exposed must then be freely touched with nitric acid. Should the parts already have fallen into a state of gangrene, emollient and antiseptic applications will generally be found to agree best; yeast, carrot, opiates, charcoal, or chlorinated poultices should be employed, the sloughs removed, and any parts, as portions of the prepuce, that are partially destroyed by the gangrenous action, slit up, so as to remove tension and lessen inflammation. In cases of inflammatory sloughing of the penis, the hæmorrhage, that occasionally results from some of the blood-vessels of the organ being opened by this action, may, if moderate, be looked upon as highly beneficial, inasmuch as it is often followed by an arrest of the morbid process. If, however, it occur to an alarming extent, the patient should be put under chloroform and the actual cautery freely applied. This not only stops the bleeding, but arrests the progress of the sloughing action. When once the chancre is healthily granulating, it must be dressed in the same way as any common ulcer.

In using lotions to any form of chancre, care should always be taken to keep a piece of lint soaked in the fluid constantly applied between the prepuce and the glans, and, in women, between the opposite labia; for, unless this be done, the contact of the diseased and inflamed mucous surfaces with one another will tend to keep up irritation and morbid action.

Constitutional Treatment.—The **Simple, Soft,** or **Excoriated Chancre** will readily heal under non-mercurial treatment; but, contrary to the opinion of many Surgeons of the present day, I consider it much safer to put the patient upon a mild course of the green iodide of mercury.

The constitutional treatment of **Phagedænic Chancre** must be directed by general medical principles; rest in bed, a mild diet, the administration of salines and opiates, in those cases in which there is inflammation and irritation conjoined; whilst in those in which there is a debilitated or cachectic condition, tonics, such as bark or iron, with good food and stimulants, may be required, together with opiates to allay pain and to procure rest. The preparations of iron, especially the ammonio-citrate and the tartrate, either alone or in combination with sarsaparilla, are especially useful in these cases. In the phagedænic chancre mercury is seldom admissible, and does much harm if employed to check any syphilitic taint that may be present with the sore. Indeed, it is the indiscriminate use of mercury in these cases that has, I believe, brought so much discredit upon this remedy in venereal diseases. But, although mercury is not generally admissible in phagedænic chancre, yet, in that form that is characterised by a white slough, it has been found useful by Wallace, and the utility of this practice I can confirm, having found it of service in some of the more rebellious varieties of this disease; the drug must, however, be very cautiously administered, and in but small doses.

In the **Gangrenous** or **Sloughing Chancre,** the constitutional powers of the patient will be found to be broken, and his general health

depressed, so that depletory measures are seldom if ever required. The prepuce should be slit up, and free incisions should be made through the sloughing textures, so as take down all tension; and as the fever subsides, or from the first if there be much asthenia, ammonia and bark, good nourishment, and abundant stimulants, will be required; eventually the patient's strength may be supported by iron and quinine, and the irritability of the system allayed by the free administration of opium; the strong nitric acid should then be mopped freely over the parts, and afterwards charcoal or yeast poultices applied until the sloughs have separated. After the separation of the sloughs, the sore will usually present a clean appearance, the granulations cicatrising rapidly. It often happens that, when a portion only of the prepuce has been destroyed, the upper part being perforated, and the preputial orifice, with the under part, hanging down under the glans, the part thus projecting may be snipped off with advantage, and the organ thus moulded into a better shape.

After a chancre has been healed in one or other of these ways, we must endeavor, by the general improvement of the patient's health, to prevent or alleviate the manifestation of syphilis, should that malady have been contracted at the time of contagion. This is usually best done by putting him on a course of sarsaparilla with the mineral acids, and by scrupulous attention for some months to his habits of life. The syphilitic poison may linger for a great length of time in the system, not declaring itself by any overt manifestation so long as the health continues good; but, if the patient fall into a debilitated state, even though some years have elapsed, showing itself by some of its local effects.

Consecutive Symptoms of the Local Contagious Ulcer.—Chancres are not unfrequently followed by a series of affections which may be termed *consecutive*, depending as they do upon the primary disease, but being local in their character, and presenting no evidence of constitutional infection. These consecutive symptoms are three in number: viz., Contraction of the Cicatrix of the Chancre, Bubo, and Warts.

Contracted Cicatrices.—Most excoriated chancres are healed without any cicatrix or other trace of them being left; but, in the phagedænic and the sloughing chancres, there is always loss of substance, often to a considerable extent, and consequently a depressed scar. But in addition to these thickenings, one of another kind may take place. The situations of all venereal ulcers should be watched for some time, however readily that sore may have healed; lest, the syphilitic virus having been introduced with the local irritant, induration should commence at the point of contagion, when the time of incubation or inactivity of the virus after its introduction has elapsed. Thus, a month or six weeks should pass away after the suspicious connection, before the Surgeon pronounces the patient free of general syphilis.

Bubo.—By bubo is meant an inflammatory enlargement of the lymphatic glands which receive the lymphatic vessels supplied to the inoculated surface. A bubo, though generally produced in the groin by absorption of irritating matter from chancres on the penis, may occur elsewhere; as, for instance, in the axilla, in cases of chancre on the finger; in the submaxillary region, if the disease occur on the lip. The enlargements of the inguinal or other lymphatic glands that occur in cases of venereal chancre, are caused by several kinds of irritation. The glands may be irritated by concomitant inflammatory action about the penis, as when balanitis or phimosis is present; or they may be enlarged from the simple excitement of the parts, especially in strumous and

debilitated subjects. In these cases the bubo is termed *Sympathetic*, and the affection must be considered as a simple irritation and inflammation of the inguinal glands, which may speedily subside under proper antiphlogistic treatment of a mild kind, although in many cases suppuration eventually takes place, constituting, in fact, a simple glandular abscess, presenting nothing in any way specific. Indeed, it scarcely ever happens that a chancre has existed for some days without the lymphatic glands in the groin becoming enlarged and somewhat indurated, especially those that lie parallel to Poupart's ligament, their enlargement being attended with a degree of stiffness and dragging pain. The liability to this irritation and inflammation of the glands in the groin is greatly increased by the patient walking about or otherwise exerting himself. But I do not think that causes such as these influence the occurrence of the other and more serious affection of the lymphatic glands; namely, the *virulent bubo*, which appears to originate from direct absorption of the chancrous pus, without the interference of any external agency. When once the glands in the groin have become virulently irritated, it is extremely difficult, if not impossible, to prevent suppuration from taking place. Usually only one or two glands suppurate, although several may be enlarged: and very commonly the disease is confined to one groin only, though both may be affected, more particularly if the chancre be situated upon the frænum. The suppuration may be limited to the gland immediately affected, or it may extend into the surrounding areolar tissue, or even be chiefly confined to this.

The true specific virulent bubo is essentially produced by the absorption and deposit of the venereal virus in the substance of the gland, the tissue of which becomes poisoned; so that we may consider with Ricord that a virulent bubo is, properly speaking, a chancre of an absorbent gland, differing only in seat from that which is situated upon the surface of the body. Ricord has observed, and I have often had an opportunity of testing the correctness of this observation, that the pus of a virulent bubo is as readily inoculable as that of an ordinary chancre. This kind of bubo, then, may be considered as a *specific* abscess of the absorbent glands and surrounding areolar tissue. It runs the ordinary course of an acute abscess, often undermines the skin to a considerable extent, with much red or purple discoloration, and, when it has burst or been opened, presents a ragged sloughy-looking cavity, having an unhealthy appearance; it most usually occurs about the second or third week after the first appearance of the chancre, but may happen at an earlier or at a later period, even after the chancre has itself healed.

A rare form of bubo is that which forms within the abdomen in the lymphatic glands in this situation. It is a very dangerous variety, and may prove fatal by rupture into the peritoneum and peritonitis.

Primary Bubo.—The French Surgeons have described a form of bubo that they call *bubon d'emblée* or *primary bubo;* this is said to occur from the direct absorption of the chancrous matter, without the previous formation of a chancre Scarcely any satisfactory proof, however, has been given of the existence of such a bubo. It frequently happens that small excoriated chancres heal in a few days, before which time, however, the inguinal glands have become irritated and enlarged; and, as the enlargement of the glands goes on after the healing of the chancre, a bubo may be formed when all trace of its primary source has entirely disappeared.

This primary bubo has fallen under my observation in one case only. Until that occurred, I doubted its existence; and I am not yet fully

convinced that this suggested mode of origin is the true one. In the case referred to, a young man applied to me with a rather large abscess in the groin, for which I sent him to the Hospital. On being questioned, he denied ever having had any venereal disease, though he admitted having had intercourse with a woman of the town. On examining the penis, no chancre, abrasion, or cicatrix could be discerned. The abscess was opened, and two ounces of rather bloody and very thick pus were let out; no enlarged glands could be seen. For the sake of experiment, the pus was inoculated into the left thigh, and two distinct and well-marked pustules were produced. That such an effect can be obtained by matter of very irritable character without any venereal origin, is shown by the experiments of several Surgeons who have succeeded in inoculating matter from itch and ecthymatous pustules; hence it must not be concluded in this case that the bubo was consequent on the direct absorption of venereal matter along the lymphatics.

Creeping Bubo.—In some cases the bubo, as has been well shown by Solly, assumes a tendency to creep or spread over the neighboring integument, extending in this way to a considerable distance down the thigh, upon the abdomen, or over the ilium. This *creeping bubo* is characterised by the peculiar semicircular or horse-shoe shape that the sore assumes, and by its tendency to cicatrise by one margin, whilst it slowly extends by the other, the cicatrix always being thin, blue, and weak, closely resembling that of a burn.

After a bubo has disappeared a good deal of induration may be left in the glands of the groin, perhaps with matting together of the surrounding areolar tissue; and this induration may continue for years, or even for the remainder of life.

The *Treatment* of bubo consists, in the first instance, in endeavoring to prevent the occurrence of suppuration; and should pus form, in letting it out, and closing the wound which results.

The *Preventive Treatment* of bubo is of considerable moment. It consists essentially in perfect rest of the part, and the application of leeches and of cold lead poultices. In reference to the application of leeches, there is a practical point of considerable importance that requires attention—viz., that the leech-bites may become infected by the chancrous pus, and thus converted into a number of new chancres. This accident is best guarded against by covering the bites with colodion and plaster.

If there be not much inflammatory action about the bubo, but this be indolent and chronic, the application of blisters or discutient plasters, or of the tincture of iodine, is occasionally useful. A plan of discutient treatment recommended by a French army-surgeon, Malplaquet, I have found very serviceable in several cases. It consists in applying a blister about as large as a half-crown over the surface of the inflamed gland, and dressing the raw surface produced by it with a piece of lint soaked in a saturated solution of the perchloride of mercury for a couple of hours, when a white eschar will have formed; a cold poultice should then be applied, and continued until all excited action has gone down.

If, notwithstanding our endeavors to prevent suppuration, matter form within or around the gland, as evinced by the swelling becoming soft, boggy, or inflamed, a free opening should be made by either a horizontal or a vertical incision, whichever will give the readiest outlet to the pus. If the integuments be much thinned, undermined, and of a bluish color, I prefer making the opening with potassa fusa, as it destroys those unhealthy tissues which would otherwise interfere with the

cicatrisation of the wound. The cavity that is now exposed presents a chancrous appearance, being irregular and sloughy, with elevated and angry red edges. This should be dressed with the aromatic wine and tannin lotion (p. 813). If the character of the sore do not improve, the potassa fusa should be freely applied to its surface and edges, and after the sloughs have separated, the granulations may be dusted with red precipitate powder, the cicatrisation will in many cases be much facilitated by the application of a compress with a spica bandage, and by keeping the patient at rest. Not unfrequently the healing of the sore is interfered with by the overhanging of the undermined edges; these may occasionally be made to retract by being freely rubbed with the nitrate of silver. If this do not succeed, it may be necessary to pare them off with a knife or scissors, or to destroy them with potassa fusa, the sore should then be dressed from the bottom, and treated on general principles. Sometimes sloughing action is set up in the open bubo, and then extensive destruction of tissue may ensue, and even fatal hæmorrhage from the femoral artery has been known to occur. If there be signs of syphilis concomitant with this local bubo, such as several indurated glands, or rash upon the skin, it is as necessary to employ the continuous administration of mercury to cure the latter disease, as if the local affection were not present.

Venereal Warts.—Various forms of warts occur independently of any constitutional affection, from simple continued irritation of the muco-cutaneous surfaces. They commonly occur on the prepuce or glans, and are especially apt to be situated in the angle between the parts; they are of a bright-red color, very vascular, and, if left without interference, may increase immensely in size and number, distending the prepuce, and giving a clubbed appearance to the penis; there is always phimosis attending them, and the tension of the prepuce may be such, that ulceration occasionally takes place in it, giving rise to a protrusion of these growths through an aperture in its side. These warts are occasionally met with in the vagina, forming large, irregular, cauliflower-looking masses. The *Treatment* consists in snipping and paring them off with scissors, and afterwards touching the parts from which they spring with nitrate of silver, to prevent their recurrence. In order to do this effectually, it is necessary to lay open the prepuce in all those cases in which the glans cannot be freely exposed by drawing this back.

II.—SYPHILIS, OR CONSTITUTIONAL VENEREAL DISEASE.

Syphilis is a specific disease, transmissible (1) by the contact of its own specific pus with a tender or an abraded surface; (2) by inoculation into the system through the medium of the secretions; or (3) by hereditary taint under certain special conditions. It manifests itself not so much by the occurrence of any one special affection, as by producing a tendency to inflammation in various tissues and organs, and by impressing a peculiar form and course on the inflammatory affections which it induces.

With the true and intimate nature of syphilis we are at present entirely unacquainted, and it would be useless to discuss those various hypotheses that refer it essentially to a specific cell, to a cryptogamic vegetation, or to a specific fever. We know this disease, like many others, by its effects only; of its intimate nature we are yet ignorant.

These effects of a syphilitic inoculation are of two distinct kinds—the plastic and the ulcerative, the types of which exist in the primary sore,

the hard base and plastic deposit around which reproduce themselves in a vast variety of forms, as in indurated glands, in nodes, and visceral gummata. The ulceration is constantly met with in those secondary and tertiary ulcers, invading skin, mucous membrane, and bones, which play such prominent parts in the ravages of constitutional syphilis, and which are often preceded by, and are the results of, the disintegration of previously deposited plastic gummata.

In these respects, indeed, the progress of an infecting syphilitic sore closely resembles that of any other disease, which, primarily local, becomes secondarily constitutional, whether it be the infective clot that leads to pyæmia, the germ of cancer, or the nodule of caseous tubercle. However much the course and progress of these diseases may differ, the parts infected and the organs involved are generally the same, whether they be "spermatised" by putrid or specific pus or by cancer-germs.

The early and more common consequences of this affection have long been called *primary* and *secondary* syphilis. These terms are ill suited to our present knowledge of syphilis, for it is now established that the induration at the point of contagion and the enlargement of the neighboring lymphatic glands are as much a part of the disease as are the eruptions of the skin and mucous membranes; which, in the great majority of cases, shortly follow the appearance of the former. But, as they have the sanction of custom, they may be employed to indicate the different phenomena of the disease. Thus **Primary Syphilis** is used to denote the induration and ulceration that take place at the point of contagion, and the indolent enlargement of the nearest group of the lymphatic gland. **Secondary Syphilis** denotes the various eruptions of the skin and mucous membranes, and the inflammation of the eye and the periosteum, which takes place in the first two years after contagion, but may return by relapses of the disease after much longer periods. Lastly, the term **Tertiary Syphilis** includes peculiar effects of syphilis that appear in a small proportion only of those infected, and which affect the body, especially the viscera, with processes of a slow inflammatory character, and are seldom set in action until the ordinary course of the disease has terminated.

Syphilis may, then, be regarded as presenting two orders of symptoms, the local and the constitutional. The *Local* or *Primary* symptoms occur only on the part to which the virus is immediately applied, and are the consequences of the introduction of the poison at the point of inoculation. The *Constitutional* or *Secondary* symptoms are the results of the absorption of the poison into the economy, whereby most of the tissues and many of the organs of the body are affected; they are capable of hereditary propagation, and, in certain circumstances, of transmission through the secretions.

It would be altogether foreign to the scope of this work were I to enter into the very curious and interesting question as to the *origin of syphilis*, a subject that admits of much dispute, and which has been keenly argued. After an attentive examination of it, I think there can be little doubt that syphilis was either introduced into Europe, or originated there *de novo*, towards the end of the fifteenth century. There is no mention made by the medical writers, historians, or poets of antiquity of any contagious disease arising from sexual intercourse affecting the genital organs, and followed by constitutional symptoms. The disease, when it first attracted public attention at the close of the fifteenth century, was looked upon as a new and previously unknown affection. It was supposed to be infectious as well as contagious, and

its treatment was not understood. This would scarcely have been the case had it been previously known by personal observation, or even by tradition, to those then living. If it had previously existed in the old world in a mild or modified form, different from what we now observe, it is certain that about this time it suddenly assumed greater intensity, all its symptoms being aggravated in a remarkable and fearful manner, presenting characters which had not been previously alluded to, but which have often been reproduced in modern times; as, for instance, in those severe forms that were observed in the British armies during the Peninsular War, and, according to Larrey, among the French troops during Napoleon's German campaigns.

Transmissibility of Syphilis.—That syphilis can be communicated through the contact of its specific pus with an abraded or tender surface, is fully established; but the question as to the contagiousness of secondary syphilitic discharges, or of the secretions of individuals laboring under constitutional syphilis, is one that is still unsettled; and, before it can be settled, very extended and accurate observation is required for the elimination of those sources of error, which are inseparable from an inquiry in which the morality of patients often constitutes an important element. The following appear to me to be the chief points that may be looked upon as decided with tolerable certainty, though many of them are still objects of controversy.

Constitutional syphilis is contagious; that is to say, it is communicable from one individual to another through the medium of the discharge of one of the sores that may form during its continuance. The fluids which by direct experiment are proved to contain the virus in a communicable form, are the secretions of all the early syphilitic eruptions; of these, the most common are the thin discharge of mucous tubercles, or of the initial ulcer. The blood itself, in more than one instance, has been inoculated with success. Professor Pellizzari, of Florence, inoculated a young Surgeon, Dr. Bargioni, on the 6th of February, 1860, with blood taken from the vein of a woman suffering from syphilitic eruptions. The site of the inoculation, which was carefully protected by a watch-glass cover, remained quiet for twenty-five days; then a papule developed, which in forty-four days became an ulcer with hard base. On the sixty-fifth day after inoculation, a roseola broke out on the trunk. Some uncertainty still exists as to whether the natural secretions of syphilitic persons are contagious of themselves, or become so by admixture with the blood or the discharge of syphilitic affections. The saliva, the milk, and the semen have been variously accused of this power. Syphilis is hereditarily transmissible from parent to offspring; it is said to be communicable to the female by impregnation by a diseased male, and even through the medium of the semen without impregnation. It is also believed by some to be communicable to the mother from a diseased fœtus in utero, the parent being thus poisoned through her own offspring. There are certain rare cases in which it has been communicated from nurses to children, and *vice versâ*, by the act of suckling, through the medium of sores or mucous tubercles on the nipple or mouth, and possibly through the secretions. And there occasionally occur cases in which the male is infected by the diseased secretions of a syphilitic female during sexual intercourse, without there being any local sore through which the poison can be proved to be conveyed into the system.

Ought a man affected by secondary syphilis to marry? is a question that is frequently put to the Surgeon, and one to which it is by no means

easy to give a direct and immediate answer. That a man laboring under constitutional syphilis is liable to infect a healthy woman, either directly or through the medium of her fœtus, or to become the progenitor of syphilised children, there can be no doubt; but that he will necessarily do so, is certainly not the case. In answering the difficult question that is thus frequently raised, the Surgeon must be very cautious; he must bear in mind that the health and happiness of a woman and the future of a family are often dependent on his reply; and that, should he give his consent to the union and evil consequences follow, the whole responsibility will be thrown upon him. I think that it may be stated generally that no man ought to marry for at least twelve months after the first development of constitutional syphilis, even though all local signs of the disease have disappeared, and that he ought not to do so whilst any local manifestations of the disease are developing themselves, whatever time has elapsed since the commencement of the attack. But, although I believe that it is safer to follow these general rules, yet I have seen so many cases in which marriage has been contracted by men still suffering from occasional manifestations of the slighter forms of constitutional syphilis, and yet no evil consequences have been entailed either in wife or children, that, although it may be safer, yet it cannot be absolutely necessary to adhere closely to the advice just given. I know instances in which men who had contracted syphilis before marriage, and had been imperfectly cured—having for many years (ten, fifteen, or even twenty) occasional outbreaks of cutaneous syphilides, sarcocele, gummata, and other varieties of the advanced forms of the disease—have been the parents of perfectly healthy children, and have never infected their wives.

It is tolerably well established that syphilis is occasionally communicated with other affections. The matter of local chancre may thus be contaminated with the syphilitic virus, if the two affections be present in the same person. Syphilis has also been spread widely among young children by vaccinating them with lymph from a syphilitic child. One of the most unquestionable of these accidents is that which occurred in the Subapennine valley of Rivalta in Piedmont, in 1861. Dr. Pacchiotti, of Turin, who was employed by the Italian government to report on the attack, has published an account of it. The facts are shortly these. In May, 1861, an apparently healthy child, named Chiabrera, was vaccinated at Rivalta with lymph sent from Acqui for the purpose. Ten days after this vaccination—on June 7th—forty-six healthy children were vaccinated at one sitting from this child. Again, on the 12th June, seventeen other healthy children were vaccinated from one of the forty-six. Thirty-nine of the first series of forty-six, and seven of the second series of seventeen, received syphilis with the vaccine disease, making a total of forty-six out of sixty-three children in a mountain village simultaneously inoculated with syphilis. Some months elapsed before the vaccination was suspected to have been the source of the children's bad health. By the 7th October, when attention was drawn to this spreading disease, six of the forty-six syphilised children had died without receiving any treatment, fourteen were recovering, and three were in a precarious condition. Twenty-three were dispersed through the country, and their condition was unknown until further researches traced them out. In addition to the children, twenty women suckling them were inoculated with syphilis from the children; through the mothers, the disease had reached some of the husbands and even the elder children of the different families. It is now generally believed that vaccine syphilis

is only spread when blood is admitted with the inoculated lymph; that pure lymph will not spread syphilis even when taken from a syphilised child; and hence that vaccination may be safely practised in some cases from a syphilised child, whilst in others infection will be conveyed when blood is mixed with the lymph.

Progress.—The effects of contagion are not immediately manifested. The time that intervenes between inoculation and activity of the poison is called the *incubation period*. It may be occupied in three ways. If the vehicle containing the virus be of a non-irritating character, the broken surface heals, and all traces of the inoculation disappears until the incubation is completed; or, as the vehicle of the virus is often pus or discharge of an irritable kind, it may cause immediate inflammatory action at the point of inoculation. This irritation subsides in a short time, and the part then remains quiet until the incubation is complete, when the syphilitic poison betrays its presence by characteristic phenomena. An experiment of Vidal's illustrates this: he inoculated the matter of a pustular syphilitic eruption on the arm of a medical student, which produced a pustule in a couple of days; this healed over in about a fortnight, and the experiment was supposed to have failed until the thirty-fifth day; action then recommenced by the development of a papule, which subsequently ulcerated, and general syphilis followed in due course. If the syphilitic virus be carried in the pus of a local contagious chancre, the time of incubation is often occupied by the course of a chancre, which may or may not have healed over when the syphilitic poison begins its action. This series of events, first a suppurating contagious sore, and then induration forming in the base of the sore, or in its scar if the sore have already healed, is perhaps almost as common as the inoculation of syphilis unaccompanied by immediate local irritation; but the two morbid actions have no connection with each other, and are only accidentally co-existent.

The length of this time of inactivity varies in different persons; it is commonly twenty-five days. The shortest known period before the poison began to reveal its presence has been ten days, and the longest forty-six days. When the time of active progress has arrived, the point of contagion becomes an elevated hard copper-colored spot, which sometimes ulcerates, and if irritated does so freely, forming the indurated or Hunterian chancre. Not unfrequently the surface scarcely ulcerates, but is simply eroded; and even erosion may be wanting, in which case the only change on the surface is simple desquamation of the cuticle.

The **Indurated** or **True Hunterian Chancre**, as it is termed, is not by any means so frequently met as the other manifestations of syphilitic inoculation. The great characteristic of this form of venereal ulcer is the induration of its edges and base; and this character is met with from the very first. Any ulcer, but more especially the chancrous excoriation, may during its progress become indurated from undue stimulation, or from being otherwise inflamed; but the Hunterian chancre is indurated from the first, and continues so throughout. This induration of the base is the result of a peculiar plastic effusion, which, though it microscopically and chemically resemble ordinary healthy lymph, yet very distinctly differs from it in its vital characters. The discharge from a soft chancre consists of pus, in no way distinguishable by the microscope from the pus on the surface of a granulating sore. The discharge from a true Hunterian chancre, when not subject to any undue irritation, consists chiefly of epithelial *débris*, floating in a clear fluid, true pus-cells being entirely absent. Besides the presence of induration,

the Hunterian chancre is characterised by its circular shape, its elevation above the surrounding parts, and sometimes by a very adherent grey slough that covers its surface. It is usually seated on the glans; but not unfrequently on the skin of the prepuce, or of the root of the penis. In this form of chancre there is almost invariably enlargement of the lymphatic glands in the groin.

Seat and Number.—The indurated primary ulcers of syphilis are most frequent on the *genitals*, but not so exclusively limited to those parts as are local venereal sores, because syphilis is communicated in various ways besides that of sexual intercourse, and thus may appear on any part of the body. Fournier found that, of 472 cases of inoculation in men, 314 were on the prepuce and glans penis, 109 on other parts of the male organ, 12 only on the mouth, 6 on the hands and fingers, and a few on the eyelids, tonsil, and navel.

Syphilis not unfrequently occurs amongst Surgeons and accoucheurs as a consequence of inoculation on the *fingers*, during the dressing of a venereal sore, or the delivery of a diseased woman; and is also occasionally met with among non-professional persons. It usually appears as a small sore by the side of the nail and under its matrix, with much swelling, redness, and pain in the finger, which becomes bulbous; pain and swelling of the axillary glands soon follow. If the nature of the disease be not recognized, the ulceration will creep round the tip of the finger, have a foul and sloughy look, with exquisite tenderness, and, resisting all ordinary treatment, may be set down as maglinant; on which supposition the amputation of the finger has been proposed and practised. I have seen at least four cases in which this extreme measure has been proposed, but in which, by a timely discovery of the true nature of the affection, the finger was saved.

In some cases of disgusting depravity, chancres are met with at the *margin of the anus* and on the *lips* and *tongue*. These are always indurated; and from their foul surface, hard base, and persistent character, may readily be mistaken for cancerous affections, but the diagnosis is easy, for it will usually be found that they occur in girls and young women who have not reached the cancerous age; indeed in women at any period of life cancer of the lips is extremely rare—so much so, that I have never seen a case. Inoculation will always determine their true nature.

Induration.—The hardening of the tissues around the point of inoculation varies in the extent to which it is developed. It is most marked in the skin, where it takes the form of a nodule or lump, often no larger than a split pea, but sometimes as large as a walnut. Now and then, on the thin prepuce, it is spread widely in a shallow layer, and gives the foreskin the "parchment induration" of Ricord. This induration remains for some time around the point of contagion, usually two or three months, though, when very scantily developed, it may vanish in a fortnight or three weeks. Ultimately it always disappears; though, if irritated, it is very apt to break down into obstinate ulcers.

It is maintained by many Surgeons of great authority, that induration of the site of contagion is by no means a constant production. The number of cases where induration is not palpably evident is very small; and, though probably it is sometimes wholly wanting, it is a rare exception for it to be so.

Much induration is often thought to produce a severe course of syphilis, and probably this is generally true; though the patient often escapes all subsequent symptoms, except a few spots on the skin and sore throat, especially when treatment is early employed.

Indolent Enlargement of the Lymphatic Glands.—The so-called *indolent bubo* is the next change to follow induration of the point of contagion, which it accompanies or very closely succeeds. One gland enlarges first, and several follow; the glands remain painless or only very slightly tender; the skin over them retains its natural color and suppleness, and there is no doughy thickness, as in the acute suppurating bubo. In this state the glands, nevertheless, not unfrequently suppurate, and an abscess forms around them. This accident is generally set up by violent exertion, such as dancing, riding and the like; but it has no special significance—it never yields a specific inoculable pus like the virulent bubo of the local chancre. The anatomical change in the glands themselves consists in congestion and the deposit of irregular fibro-plastic lymph, which produces their increased size. If the point of contagion be seated near the middle line, at the frænum for instance, the glands in both groins are often enlarged.

In weakly persons, the glands throughout the body become enlarged; those at the back of the neck, especially, are very commonly enlarged during the time of the eruption on the skin, and those of the axilla and other parts are sometimes included in the enlargement. This condition of the glands is accompanied by a great increase in the proportion of colorless corpuscles in the blood; but both these alterations of the lymphatic system are temporary, and disappear spontaneously in a short time.

Treatment.—**Local Treatment**, while of much value in the non-syphilitic venereal sore, is of little or no avail in the disease now under consideration; the causes of the local manifestations being beyond the reach of any direct application. The treatment must be directed to the neutralisation of the action of the poison, and its removal from the constitution, by remedies given so as to act generally on the system.

The **Constitutional Treatment** of primary syphilis has undergone various changes according to the prevailing doctrine of the day. It had been decided by the Surgeons of the last and early part of this century, that mercury acted as a specific against the syphilitic poison. This doctrine was so firmly established, that Hunter, and many of the great surgeons of his school, looked on the curability of a sore without mercury as a proof that it was not syphilitic.

About the commencement of this century, however, it was found by observations of the Army-Surgeons, amongst whom Rose took a principal share in the inquiry, that the different forms of venereal ulcer, no distinction being then drawn between the local non-infecting sores and the ulcers which resulted from the contagion of the constitutional disease, were curable without the necessity of administering mercury, or indeed of having recourse to any specific treatment whatever.

These observations, which appear to be founded on what was witnessed in Spain and Portugal during the Peninsular War, led to the introduction of an important modification in the treatment of venereal sores; viz., the *non-mercurial* or *simple* plan, as it is termed; a mode of practice that obtained great favor, and has been extensively tried. Of late years, however, a reaction has taken place in the minds of most professional men, and mercury is again employed in the treatment of this disease, but more moderately and scientifically, and consequently more successfully than before.

The arguments in favor of the non-mercurial plan of treatment are briefly these; that by this system of treatment the constitution of the patient is saved the introduction of a mineral which in many cases

acts injuriously, and which, as the disease can be cured without it, may at all events be looked upon as unnecessary; that secondary affections less frequently follow this plan than they do the administration of mercury; and, lastly, that those distressing cases of constitutional syphilis which are common after mercurial courses, and which are said to depend upon a peculiar combination of the syphilitic poison with the mineral in the system, are never met with in persons who have undergone the simple treatment. These arguments, however, on closer examination and further experience, have been proved to be not quite so conclusive as the supporters of the simple treatment appear to believe. That a great number, perhaps the majority, of cases of simple soft chancre, which we now know to be an affection of a totally distinct nature from syphilis, can be healed without the administration of mercury, is undoubtedly the fact; but it is equally true in many instances that the indurated sore does not cicatrise properly unless the mineral be administered, or, if it do close, that it heals in an imperfect manner, readily breaking out again. But it is a most serious error to confound the healing of ulcers with the cure of syphilis. The cicatrisation of an ulcer and neutralisation of the constitutional affection are two distinct things; and the test of the relative value of these two plans of treatment must depend rather on the influence they have over the course of syphilis, and on the character that the symptoms assume under one or other of these methods, than on the mere skinning over of the ulcer. I cannot agree with the statement that secondary symptoms are less frequent after the simple than after the mercurial treatment of syphilis. I have seen the non-mercurial plan of treatment very extensively employed at University College Hospital; indeed, it was formerly almost invariably practised there, more particularly in the syphilitic cases occurring among the out-patients under Morton, who strongly advocated it; and I have had repeated occasion to observe the frequency with which it was followed by secondary symptoms. In private practice, also, I have had considerable opportunities of comparing the two methods; and I can safely say that I have seen the simple treatment more frequently followed by secondary symptoms than the mercurial plan has been, when properly and judiciously employed. The supporters of the non-mercurial treatment, when obliged to admit the great frequency with which it is followed by secondary symptoms, argue that these, if more frequent, are less severe after the simple than after the mercurial plan; and they state somewhat dogmatically, and it appears to me without any evidence to support their statement, that mercury and syphilis together form a sort of poisonous compound in the system, which produces the worst and most destructive forms of constitutional syphilis. I deny, entirely, however, that we have any proof of the existence of such a combination as that which is supposed to be produced by syphilis and mercury; no evidence with which I am acquainted has ever been adduced in support of the formation of such a poison in the system. It is doubtless true that, after an ill-regulated mercurial course, constitutional syphilis of a very severe character may occasionally appear; but this seems to me to be rather owing to mercury having been improperly administered in constitutions that will not bear it, and in which, by the induction of a cachectic and depraved condition of the system, it favors the occurrence of some of the more severe forms of secondary syphilis, in the same way that any other lowering plan of treatment, or simple debility, might occasion them, but without the exercise of any specifically injurious influence. Some of the worst forms of constitutional syphilis that I have seen

occurred in patients to whom no mercury had been administered, but in whom the syphilitic virus had been allowed to exercise its influence unchecked, save by the so-called simple treatment. I have seen the body covered by immense ecthymatous crusts and sores in one case, rupial ulcers with destruction of the nose and palate in another, the worst kind of syphilitic cachexy with the tuberculo-pustular syphilide in a third, and extensive disease of the cranial bones and the clavicle in a fourth; in none of which had any mercury been administered.

But, though I cannot admit that the supporters of the simple or non-mercurial treatment of syphilis have brought forward any proof of its superiority over the mercurial plan, and though my own experience has taught me that secondary symptoms occur after it with no less severity, and with far greater frequency than they do when mercury is carefully and judiciously administered, yet I am quite ready to allow that there are certain conditions of syphilis in which the non-mercurial treatment alone is admissible, the state of the constitution or the disease being such that mercury cannot be given in any form In these cases such a treatment must be adopted, in accordance with ordinary medical principles, as will tend to subdue local action and improve the general condition. It is, indeed, especially in individuals of an unhealthy or strumous habit of body, or in those who are suffering from local visceral disease of some kind, and who are not affected by any indurated chancre, that this plan of treatment should be adopted. So also in those who, from the nature of their occupations, are subjected to much exposure to wet and cold, a mercurial course cannot be properly or safely administered, and the simple treatment is the most advisable plan that can be adopted. But even in such individuals mercury is often necessary to destroy the activity of the disease In all other cases, I am certainly of opinion that mercury ought to be administered; and this opinion appears to be entertained by the most experienced Surgeons of the day in this country and abroad.

The first question in connection with the employment of mercury in syphilis has reference to the principle on which this remedy is administered. Whether mercury exercises a specific action over the poison of syphilis or not, has been much discussed, and is difficult of proof. I certainly think that it does act as a specific in syphilis, but that this specific action is much influenced by the condition of the system, the habits of the patient, and the mode of administering the remedy; these conditions under certain circumstances tending to counteract or otherwise to interfere with its operation. That mercury in many cases is antagonistic to the syphilitic poison, appears evident from the fact that in some instances hard ulcers will not heal unless it be given internally; from its influence in speedily curing infantile syphilis and preventing after-manifestations in the system; and from the fact that, when properly administered in *healthy constitutions*, it may almost to a certainty be expected to dissipate the various symptoms of constitutional syphilis. When it fails, as it doubtless does in many cases, to prevent the constitutional infection, or to eradicate this if it have appeared, the failure may usually be traced either to want of care in the administration of the medicine, or to the existence of an impaired state of the patient's health; though doubtless, in some cases, the most judicious employment of mercury is unsuccessful in arresting the progress of syphilis. The essential practical point in the treatment of primary syphilis by mercury is to keep the patient under a prolonged and mild course, rather than a short

and active one. The gums may be "touched," but profuse salivation should be avoided.

In connection with the administration of mercury in syphilis, therefore, various questions present themselves, the proper determination of which is of the first importance. These have reference to the State of the Patient's Constitution, the Condition of the Sore, and the Mode of Administration of the Remedy.

The *State of the Patient's Constitution* influences materially the propriety of the administration of mercury. In ordinary healthy constitutions, it may always be safely employed; but, if the powers of the system have been broken by excesses of any kind, if the patient be of a strumous habit of body, if he be irritable, feverish, or excited, it must be given with great caution, or should be withheld until these states of the system are modified or removed. It is especially by administering mercury to strumous and cachectic patients, or to those whose powers have been broken by habitual dissipation, that so much mischief results; and that it occasionally gives rise, by acting as a depressing agent, to local sloughing, or to some of the low forms of secondary syphilis.

Mode of Administering Mercury.—The particular *preparation of mercury* to be given, the *length of time* during which it should be continued, and the *rules to be observed* during the mercurial course, are all matters that influence greatly the result of the treatment.

Mercury may be administered in four ways: by the mouth, by inunction, by subcutaneous injection, or by fumigation. When it is to be given by the mouth in early syphilis, and when it is desirable to produce but a moderate effect upon the system, I prefer the iodide of mercury, in doses of one grain three times day; or the Plummer's pill, in five grain doses twice or three times a day, will be found extremely useful when the constitution is somewhat irritable. If it be desirable to produce a rapid effect upon the system, five grains of blue pill may be given night and morning. The other preparations of mercury are not, I think, required in the primary form of the disease. When it is required to produce a moderate effect, especially in somewhat delicate persons, without irritating the system or inducing much salivation, the iodide is certainly to be preferred to all other preparations.

In some cases the bowels are so irritable, that the administration of mercury by the mouth invariably purges the patient; in these circumstances, the mercurial inunction may be conveniently practised. This is best done by rubbing a drachm of the strong ointment into the inside of each thigh for ten minutes every night and morning; or by putting a similar quantity upon a piece of lint, and letting the patient wear it during the day and night in each axilla. It must be borne in mind that the orifices of the sweat-glands and hair-follicles become filled with the ointment; so that, should salivation commence, it is impossible at once to arrest the absorption of the mercury.

The duration of the mercurial course must depend upon the effect produced upon the sore. The course need not be continued until this has cicatrised, but should be persevered in until all specific action has ceased, and the sore has acquired a healthy and healing state. This impression is seldom produced upon the sore, without a slight effect upon the mouth having been previously induced; the gums becoming spongy, red, and swollen, and an increased flow of saliva taking place. It is never necessary to continue the mercury so long, or to give it to so great an extent, as to produce very profuse salivation. It was in attempting to do this, and by administering the remedy in too large a

quantity, and too rapidly, that the older Surgeons produced such injurious consequences. The effect upon the sore, rather than that upon the gums, should be our guide as to the proper time for discontinuing the mercurial.

The rules to be observed during a course of mercury exercise considerable influence upon the effects produced by it. The system should always be prepared for its administration by a free purge. While it is being given, the patient should, if possible, be kept in bed, or at all events be confined to the house, taking as much rest as possible; the diet should be moderate and unstimulating, and the dress be as warm as the season will admit. If the mercury be given by the mouth, and gripe, it will be found useful to combine it with capsicum. If it purge, small doses of opium may advantageously be administered in conjunction with it. After it has been carried to the full extent deemed advisable, it should not be suddenly left off, but gradually discontinued by diminishing the quantity daily during a week or ten days. If it be given in accordance with these rules, and in proper constitutions, we shall seldom find any of those injurious effects produced that were formerly described as resulting from the administration of this mineral; those severe and extensive forms of ulceration of the mouth, leading to necrosis of the jaws, and the mercurial erythema or erethismus described by the older Surgeons, are now happily almost matters of history, being but seldom if ever met with.

SECONDARY, TERTIARY, OR CONSTITUTIONAL MANIFESTATIONS OF SYPHILIS.

The introduction of the syphilitic poison into the general system gives rise to two very important groups of phenomena: first, those that affect the system generally, influencing deeply the condition of the blood and the nutrition of all the textures of the body, occasioning febrile disturbance, followed by emaciation, cachexy, and general evidences of malnutrition: secondly, a variety of local diseases, which are characterised by distinct phenomena:—1. Modification of the skin and mucous membrane, as observed in mucous tubercles, psoriasis, and analogous affections, and ulcerations, affecting the skin and mucous membranes in various parts of the body; 2. The deposit of lowly organised lymph in various tissues and organs, as the periosteum, the iris, testes, &c.

The period at which syphilitic eruptions appear usually varies from six weeks to six months after the formation of the indurated sore. Occasionally secondary syphilis shows itself earlier, about the second or third week, when it may be coincident with the existence of primary syphilis. Most commonly its symptoms are progressive—the milder, such as the affections of the skin and mucous membrane, occurring first; the more severe, as those of the bones and internal organs, afterwards; but in other cases this progression is not observed, symptoms of great intensity setting in early, without being preceded by those of a slighter kind.

It is extremely difficult to say when syphilis can be eradicated from the system; and indeed it is a question whether it may not impress the constitution in a peculiar way, modifying certain actions during the rest of life, as we know to be the case in other specific diseases, such as cow-pox or scarlet-fever. Certain it is that, if neglected or improperly treated, it will affect the system for an indefinite time, declaring its existence by exciting and modifying various local inflammations years after the original absorption of the poison. It is tolerably clear that a person who has once had the usual course of syphilis and has recovered

from this malady, cannot have it a second time, though he contract a fresh chancre. This rule is from time to time proved to be generally true by the occasional observation of undoubted exceptions, where repetition of the disease from re-inoculation of the virus takes place. But such cases are exceedingly rare, and occur only after an interval of some years has elapsed between the two attacks. Hutchinson has related a very interesting example of this kind in a medical student, who also suffered from two attacks of small-pox. Daily experience shows that in many constitutions syphilis cannot be eradicated, and that in most others, when it once has occurred, it is apt, even when apparently cured, to modify certain cutaneous and other affections in a remarkable manner, after a lapse of many years; showing clearly that, if the poison no longer exist in the system, the constitution has received a peculiar impress from it, which it is long in losing. E. Wilson attributes many of the ordinary non-specific cutaneous diseases to the latent influence of constitutional syphilis. These remote effects of syphilis have by Ricord been called *Tertiary*. This term is convenient, as indicating a peculiar stage of the constitutional manifestations, in which the tissues are more deeply affected than in the secondary forms of the disease.

There is no distinct line of demarcation between secondary and tertiary syphilis. It is impossible to say when the disease ceases to be secondary and begins to be tertiary. The extremes of each stage are distinctly recognizable as belonging to one or the other group. Thus the rashes are undoubtedly secondary—the gummata as certainly tertiary; but the allocation of many of the intermediate conditions is ill-defined. It is a remarkable fact, noted by Lancereaux, Berkeley Hill, and Wilks, that the severity of the tertiary phenomena is in the inverse ratio of that of the secondary. This fact is particularly noticeable in tertiary syphiloma of the nervous system; and what is also remarkable is this, that many of the more chronic and severe cases of tertiary syphilis are the result of but slight primary sores; and although it would not be possible to say that the severity of the tertiary disease is in the inverse ratio of that of the primary, as we may say with respect to the secondary, yet it may be affirmed that the severity of the tertiary symptoms has no direct relation to the size, persistence, or severity of the primary disease.

The tertiary disease is more chronic, less contagious, and less easily hereditarily transmissible than the secondary. It differs in this respect also, that it is more characterised by localised hypertrophies, by lowly organised plastic deposits, and less by acute inflammatory mischief and ulceration, than the secondary. Simon explains this fact by the gradual weakening of the syphilitic poison, which, in its stronger doses, capable of producing acute inflammatory phenomena, will in its more chronic and weakened form only be capable of developing hypertrophic changes and tumor-formations.

We thus see a continuous chain of pathological sequence established between the ulcerated induration of the primary sore, the acute, often febrile, inflammation of the secondary disease, with its ulcerative tendencies, and the more chronic forms of tertiary syphilis, with its gummata and localised neoplasms.

Although the disease may continue to modify the system for years, or even for life, yet it seldom proves fatal. In some cases, however, death may occur, either by the cachexy that is induced, by the supervention of phthisis, or by caries of the skull or nodes of the dura mater, and disease of the brain and cord. Fatal and specific syphilitic diseases of the

lungs and brain have been described of late years with much care, though there still remains a good deal to be ascertained of the relation of syphilis to these changes in the brain and other viscera.

It is especially when the disease has reached the tertiary stage, that it runs so protracted and tedious a course. When the syphilitic manifestations are confined to affections of the cutaneous and mucous surfaces, the disease may and occasionally does, wear itself out—the *materies morbi* being apparently carried off by the secretions of these tissues; and it is only in this way, I believe, that the affection can be eradicated from the system.

That constitutional syphilis is dependent on the absorption of the syphilitic poison into the blood, and its consequent general diffusion through the system, there can be little doubt. Not only is this rendered evident by the great variety of tissues and organs in which it manifests itself locally, but also in the induction of the peculiar syphilitic cachexy.

PHENOMENA.—Constitutional syphilis may affect the following tissues and organs, and usually does so in the order in which they are mentioned:—viz., the skin, mucous membranes, periosteum, and bones; the throat, tonsils, palate, eyes, nose, larynx, tongue, and testes.

The first general disturbance of syphilis is often ushered in by febrile symptoms. In proportion to the severity of these, are usually the rapidity of the progress and the extent of the local manifestations. In this febrile disturbance, the nutrition of all the tissues of the body becomes seriously impaired, and the patient acquires a peculiar cachectic look. In other cases the patient gradually falls into a feeble and emaciated condition, becoming sallow and earthy-looking, with loss of hair, and depression of mental and bodily vigor. In this condition, not only are the nutritive functions impaired, as is evidenced by his becoming weak and thin, but the reparative actions are lessened, wounds do not heal kindly, and fractures are slow in uniting, and may not unite at all until antisyphilitic remedies are administered.

The syphilitic affections occurring on the skin and mucous membranes are usually secondary, though some belong to the tertiary group; whilst those of the bones and different organs, as the larynx and testes, are commonly tertiary. Although the integumental structures are usually first affected, yet sometimes the disease first attracts attention by its attacks upon the deeper and more important tissues, the symptoms of its progress on the skin and mucous membranes having been entirely overlooked. In women, it is constantly the case for the eruptive stage to be confined to a few mucous patches of the vulva and excoriations of the fauces, the former only of which are sufficiently annoying to attract the patient's attention.

CIRCUMSTANCES INFLUENCING PROGRESS.—The severity and manifestations of general disorder which follow the contagion are very various; thus, a widely and long indurated ulcer foretells with few exceptions a long and severe course of syphilis; so, also, a short interval between the appearance of the symptoms of general disorder at the point of contagion will also indicate a severe course of the disease, and a long interval a mild course of the after-consequences.

That the *treatment of the primary sore* exercises considerable influence cannot be doubted. The severity of the course of syphilis is, I believe, materially lessened, and not in any way increased, by a mercurial course, if that course be properly conducted.

The *state of the patient's health* also determines to a great extent the kind of attack he will have to undergo. If, after the cure of the primary

disease, his health continues good, the patient may almost wholly escape further symptoms of the disease; but if the health be broken or cachectic, then secondary syphilis will occur contemporaneously with, or at a very early period after, the primary disease; and, indeed, I generally look upon the chance of the speedy supervention of secondary syphilis as more immediately dependent on this than on any other cause. It is remarkable for how long a time the syphilitic poison will continue dormant in the constitution without producing any local manifestation of its existence, until this is developed under the influence of a broken state of health. I have had under my care an extremely severe case of constitutional syphilis, in which twelve years elapsed after the occurrence of the primary disease, during the whole of which time no secondary affection was observed until the patient's health gave way from other causes. And I have also had under my care an officer, in whom a very severe form of constitutional syphilis occurred, for the first time after salivation for hepatic disease, five years after the primary sore had been contracted—no constitutional manifestation having attracted the patient's notice in the meanwhile. Not only does a state of ill-health hasten the occurrence of secondary syphilis, but cachexy, neglect, or indifference to its existence may keep it up indefinitely

The question as to their being any connection between the *nature of the primary sore*, and the *character of the consecutive constitutional affection*, has been much discussed; and I agree with Carmichael, that the different forms of primary sore will, if left to themselves, be followed each by its own peculiar train of constitutional symptoms. In fact I am fully convinced, as the result of much and close observation on this point, that there is a general correspondence between the kind of ulcer and the manifestations of constitutional syphilis that may follow it; both, in fact, being chiefly dependent upon the state of the patient's health. The same condition of system, for instance, that will occasion the local chancre to assume the phagedænic or sloughing form, will occasion rupia or ecthyma, with necrosis or caries of the bones, as the constitutional manifestations of syphilis; whereas that which occasions the indurated chancre will equally modify the secondary disease, so that it assumes a squamous form, accompanied perhaps by iritis and periosteal disease; and the soft or excoriated chancre will generally be followed by papular or roseolar eruptions, with mucous tubercles on the tongue or throat. That these sequences are of very frequent occurrence I cannot doubt, having frequently found them; and that they are not of constant occurrence is, I believe, owing to the character of the constitutional affection being modified, by the state of the patient's health having undergone a change subsequently to the cure of the primary sore, or to the patient not having been infected with syphilis when he contracted the local sore, and having thus not been rendered liable to constitutional infection. A patient having indurated chancre, will usually get psoriasis as the secondary cutaneous disease; but if he fall into a cachectic state of health between the healing of the chancre and the supervention of the constitutional affection, rupia will manifest itself.

TREATMENT.—In the treatment of constitutional syphilis, our object is not so much to relieve or to remove any local morbid condition, as to eradicate a poison from the system; and, indeed, the various local manifestations, more especially those that appear on the cutaneous and mucous surfaces, may possibly be efforts of nature for the elimination of the virus from the system through the medium of the great excretory and emunctory organs, and it is often apparently by aiding this natural

action by the administration of those remedies that act upon the tissues, that the poison is most effectually eradicated.

During the continuance of the pyrexia which often ushers in the secondary symptoms, little can be done in the way of specific means for the removal of the disease from the system; rest and mild antiphlogistic treatment being all that can be accomplished during this, the stage of invasion and constitutional reaction. Great relief is, however, afforded by a few doses of mercury given so as to affect the system. At a later period, when the cachexy which is attendant on the disease has declared itself, attention to the hygienic and dietetic management of the patient is of the utmost importance; a light nourishing diet, often accompanied by the moderate use of wine or beer, and in some of the lower forms of syphilis in broken constitutions, a general tonic plan of treatment, such as the administration of bark, quinine, or iron, and more especially of cod-liver oil, with the mineral acids and sarsaparilla, are required in combination with the more specific means that we possess for the eradication of the disease from the system. These hygienic and tonic remedies must be administered in accordance with general medical principles, and no special instructions need consequently be laid down for their use here.

The treatment of syphilis is conducted on one of these principles:—1, by the administration of mercury, with the view of directly and specifically eliminating the poison from the system; 2, by the preparations of iodine, which are supposed to be specific in a minor degree than mercury in this disease; and 3, by simple attention to the state of the general health, without any attempt at specific treatment. These different principles may be employed simultaneously or consecutively. As a general rule it may be stated that, the longer the interval that separates the constitutional from the primary symptoms, the more they partake of a *tertiary* character, the less necessity there will be for specific treatment, and the more important will be the employment of all means calculated to improve the health.

Of the value of *mercury* in constitutional syphilis, every Surgeon of experience must have had abundant proof. It may admit of doubt whether mercury can be justly considered as exercising a *specific* action, as there are some cases of the disease that it certainly does not appear to influence in a beneficial manner, and others the severity of which is certainly increased by the administration of this remedy; but it appears to me that in these cases it is rather the patient's constitution, which does not bear the remedy well, than the disease that is at fault. We know that in many states of the system, and in many individuals unaffected by syphilis, mercury acts injuriously, more especially when anything like cachexy is present; and we cannot but suppose that the same injurious influence on a particular habit of body must continue, though it be contaminated with the poison of syphilis. The best proof that we possess of the influence of mercury over constitutional syphilis—an influence, indeed, that almost approaches to the nature of a specific action—is in the case of infantile syphilis; here mercury will not only cure the disease, but will eradicate the virus from the system in a way that no other remedy can accomplish.

In the treatment of constitutional syphilis with mercury, everything depends on the proper administration of the remedy at a suitable period of the case, and in a fitting condition of the constitution. The question as to the propriety of the administration of mercury in constitutional syphilis, the particular preparation to be used, and the period of the disease in which it should be given, must be determined in a great mea-

sure by the previous treatment of the primary disease, by the condition of the patient's general health, and by the duration of the secondary symptoms. If mercury have been freely given, perhaps in repeated, irregular, and ill-conducted courses, for the cure of the primary affection; if the patient have fallen into a cachectic state, having lost flesh, color, appetite, and spirits; if the constitutional affection have assumed the tertiary form, and have deeply implicated the bones, mercury should not be given at all; or, at all events, not without proper previous preparation. In these circumstances I think we should endeavor, if possible, to remove the constitutional affection without mercury. It is true that in many cases we shall not succeed in doing so; but at least we improve the health, check the disease, and bring the patient into a proper condition to support a mercurial course, should it be thought necessary eventually to subject him to one. It is in these conditions of the system that the *nitro-muriatic acid* and *sarsaparilla* are of much service. From twenty to thirty minims of the dilute acid, with half an ounce of the fluid extract of sarsaparilla in four ounces of water, may be administered three times a day. To this the *iodide of potassium*, in five-grain doses, may often be advantageously added; or this salt may be given alone in some bitter infusion, as of cascarilla, quassia, or bark; or, if the patient be in a very cachectic and emaciated state, in cod-liver oil. The *iodides of sodium* and *ammonium* have also been highly spoken of, especially by some Italian practitioners, in the treatment of constitutional syphilis. In the more advanced cases of the disease, when it has assumed the tertiary form, and the constitution is much broken and the patient anæmic, the preparation of *iron* may be given with much advantage. When there is great emaciation, I have found the combination of the iodides of potassium and of iron with cod-liver oil, or the tartrate of iron, in sarsaparilla, to be especially beneficial. But useful as these remedies, especially iodide of potassium and the dilute mineral acids, unquestionably are, more especially when administered in the compound decoction of sarsaparilla, I do not believe that they exercise any specific influence on the disease, or that they do more than relieve or remove local manifestations, often of a troublesome and disfiguring character; failing altogether to cure the constitutional affection and to eradicate the virus from the system, for which purposes mercury will at last be required. Their great utility appears to consist in removing cachexy, and in restoring the vigor of the nutritive and reparative actions, which are in abeyance; and, by improving the general tone of the system, in enabling it to resist more effectually the advance of the disease, and in some cases, perhaps, to allow this to wear itself out. That great advantage results from maintaining the tone of the system in syphilis, is undoubted; we always find that the intensity of the ravages of the syphilitic poison is in direct proportion to the debility and want of resisting power in the constitution of the patient. Besides being useful in this way, these remedies are often of service in removing local affections, and in repairing the injury inflicted upon tissues and organs by the low and specific inflammation that is set up in them. In this respect, indeed, more particularly in its advanced or tertiary stages, when the specific nature of the disease is to a great extent worn out, and little remains but to correct the cachexy and malnutrition that have been left as the result of long-continued ill-health, nothing can exceed the value of these remedies in constitutional syphilis. I do not, however, believe that the disease can be eradicated from the system by these means, or that any of these remedies, even the iodide of potassium, can

take the place of mercury in the treatment of constitutional syphilis; indeed, I cannot call to mind a single case in which this form of the affection has been radically and permanently cured without the administration of mercury. Those cases in which they exercise the most beneficial influence, are certainly instances in which mercury has been injudiciously employed, either for the primary or the secondary disease, and in which the powers of the constitution have in this way been sapped. In these circumstances, a course of the iodide of potassium, of the mineral acids, or of the tartrate of iron in sarsaparilla, should always be administered, with a view of improving the patient's general health.

Looking, therefore, upon *mercury* as the only remedy we possess that influences directly and permanently the syphilitic poison, I think that it should always be administered in a full course during some period of the treatment of constitutional syphilis. The time at which it should be given is of considerable importance; thus, it is usually better not to administer it until the initiatory pyrexia has subsided under the use of ordinary antiphlogistic treatment; nor should it be given if there be a very marked cachexy. After this has been removed, however, by other means, the employment of mercury may be proceeded with.

In administering this remedy for constitutional syphilis, we must not give it largely, so as to affect the system rapidly, but as a mild course for some weeks, so as to act freely upon the secretory and excretory organs, and thus to eliminate the poison from the system. The most useful preparations are the perchloride, in doses from the twelfth to the eighth of a grain; or the green iodide in one-grain doses three times a day. These should be given with sarsaparilla, which keeps up the power of the system and acts freely upon the kidneys and the skin. The mercury should be continued for at least from three to six weeks, until a decided improvement has taken place in the constitutional symptoms. I do not think it desirable to produce salivation; all the good effects of mercury can be obtained far short of this; and, indeed, if the remedy be pushed to such a point as to affect the mouth or gums, it will commonly act injuriously, by depressing the powers of the system too much. I therefore think it well to suspend its administration whenever an impression has been made upon the disease, and before its depressing effect has been produced. The cautions necessary during the mercurial course, when administered in secondary syphilis, are precisely similar to those that we have described as necessary during the primary treatment of the disease.

In some cases of constitutional syphilis, affecting the skin and more superficial structures, mercury may conveniently be administered by *fumigation*. This plan of treatment, which has been especially recommended by Langston Parker and H. Lee, consists of a combination of vapor-bathing and of mercurial fumigation; and these gentlemen speak in the highest terms of the value of this remedy in syphilis, as shortening the duration of ordinary treatment, and permanently curing the disease without the constitution of the patient being in any way injured by its employment. The baths may also be associated with appropriate internal treatment. During the use of the fumigations, the patient should be dieted, and be put on a full course of sarsaparilla. The bath may be administered every second day, and should consist of about a drachm of cinnabar slowly volatilised by means of a spirit-lamp, at the same time that steam is disengaged from boiling water. In this way I have often used fumigations at the Hospital and in private practice, and with very great success, in cases of syphilitic cachexy with

extensive cutaneous disease of an ecthymatous or rupial character, in constitutions in which mercury could not be borne in any more active form. H. Lee prefers calomel as the material to be volatilised, twenty to forty grains being used on each occasion.

Subcutaneous injection of mercury has been employed by Lewin and other Surgeons on the Continent, and by Walker of Peterborough in this country. The salt used is the perchloride, of which from one-eighth to one-fourth of a grain is injected in solution in 15 minims of water. Sigmund of Vienna, who has tried this remedy in two hundred cases, insists strongly on the necessity of rest after the injection, so as to obviate the occurrence of abscess and other untoward consequences which have been observed to follow it. The precise value of the subcutaneous injection of mercury in syphilis has, it seems, yet to be determined. Sigmund believes it to be most useful in the constitutional forms of the disease affecting the more superficial structures and the osseous, muscular, and fibrous tissues.

Whatever plan of treatment is adopted, it should be carried out for a sufficient length of time; great evil often resulting by intercepting it too suddenly, and being contented with the removal of the local mischief, whilst the disease is left firmly seated in the constitution.

LOCAL SECONDARY AFFECTIONS.—We shall next proceed to describe the character and treatment of the different *local forms* in which constitutional syphilis manifests itself. These may be considered as they affect different tissues and organs, and require separate examination, according to the part that is influenced by them. We shall consider them as affecting the skin; the mucous membranes of the mouth, nose, tongue, palate, and larynx; the eye, bones, testes, and muscles.

1. **Syphilitic Affections of the Skin.**—Syphilo-dermata or Syphilides present various modifications of appearance, corresponding very closely to the different groups of idiopathic cutaneous diseases; thus we find exanthematous, papular, squamous, vesicular, pustular, and tubercular syphilitic affections of the skin, with various ulcers and growths. These differ from the corresponding simple cutaneous diseases, in their redness being more dusky or coppery, in leaving stains of a brownish or purplish hue, in their outline being circular, and in their crusts or scabs being dark, blackish, thick, and rugged-looking. Besides this, syphilis modifies materially the general character of the cuticle, causing it to assume a yellow or earthy tint, and to be rough or powdery. The worst forms of these affections are commonly met with on the face and more exposed parts of the body.

Syphilitic skin-diseases arrange themselves under the following groups.

The *Roseola* consists of blotches of a reddish-brown or coppery tint, which become more distinct as the redness declines; they vary in size from small circular spots to large and diffused patches. These are usually first observed about the abdomen, and commonly occur early in the disease, often before the primary sore is healed. Syphilitic roseola usually occurs in patients who have had chancrous excoriation, and is very frequently accompanied by an erythematous condition of the throat.

The *Squamous* syphlide occurs in small patches of an irregular shape, of a red and somewhat coppery color, which are commonly covered with thin filmy scales. In many instances the patches are, however, quite smooth, so as to have a glazed and almost shining look. They are usually situated on the inside of the arms and thighs, often on the scrotum and penis, even occurring on the glans. They also frequently appear on the palms and soles, where deep fissures and cracks are met

with. About the lips, the squamous syphilide gives rise to deep and troublesome fissures. It is often associated with a deep and excavated ulcer of the tonsils, with inflammation of the iris, and not uncommonly with disease of the periosteum and bones, and almost invariably follows the indurated chancre. Associated with this condition are large brown patches or maculæ, which occur on various parts of the body.

The *Vesicular* syphilide is of very rare occurrence. In one case which fell under my observation, it appeared in the form of clusters of small pointed vesicles, which, on drying, left grey or brownish crusts and coppery marks.

Syphilitic *Pustules*, on the contrary, commonly occur; beginning as small hard papulæ of a coppery hue, slowly softening in the centre into a small deeply seated pustule, having a large brown or coppery areola, and forming specially large circular dark-brown or even black scabs, usually flat and irregularly crusted, at other times conical. When flat, they constitute syphilitic ecthyma; when conical, the rupial form of the disease. After their separation, troublesome ulcers of a circular shape, and with a rather foul surface, are commonly left. The disease first appears upon the face, but speedily shows itself on various parts of the body, more especially on the extremities; it is always indicative of constitutional cachexy, and often appears at an early period after phagedænic chancre; when it follows other forms of chancre, this is, I believe, owing to the patient's system having in the mean time fallen into a low and broken state.

Syphilitic *Tubercles* commonly occur as an advanced or tertiary symptom; they appear as hard, smooth, flat, and elevated bodies of a reddish-brown or purplish color, seated on the face, the tongue, the limbs, the penis, or the uterus. They may be resolved by proper treatment, but have a great tendency to ulcerate and to destroy the parts on which they are situated, giving rise to large, deep, foul, and serpiginous sores.

Syphilitic *Boils* of an indolent character, but painful, and discharging a thin ichorous pus, with a core of shreddy areolar tissue, and leaving deep, irregular, and foul ulcers, are not commonly met with.

Syphilitic *Ulcers* may result from pustules, tubercles, or boils, or may commence as tertiary sores; they frequently occur where the integuments are thin, or where they are moistened by the natural secretions of the part. They are circular with elevated edges, and tend to spread in circles, with a foul greyish surface; often creeping along slowly, and destroying deeply the parts they affect; leaving cicatrices of a blueish or brown color, thin and smooth, which are apt to break open again on the application of any slight irritation.

The *Hair* and *Nails* are commonly affected in advanced constitutional syphilis; baldness, constituting *Syphilitic Alopecia*, occurring either generally or in patches, without any apparent disease of the skin. Disease of the nails, *Syphilitic Onychia*, occurs in two forms, either as a foul ulceration between the toes, or else as a chronic inflammation, with fœtid discharge in the matrix of the nail; which becomes black, more or less bent, and scales off with the formation of a dirty ulcer under its detached edge.

The *Treatment of Cutaneous Syphilis* must be conducted in accordance with the general principles already laid down, and with special reference to the characters of the concomitant constitutional condition, or of the other local manifestations accompanying it. In the early stages, when ushered in by febrile disturbance, a mild antiphlogistic treatment is required; when the pyrexia has been subdued, more specific

measures must be had recourse to. In the *roseolar* forms, the treatment of the secondary affection should be guided by the previous management of the primary sore. If mercury have been given for this, we should content ourselves with the iodide of potassium in infusion of quassia, or, what is better, in full quantities of the compound decoction of sarsaparilla. Should mercury not have been given for the primary sore, recourse must now be had to it. In the *squamous* syphilide, mercury, I think, is always necessary; and here I give the preference to the iodide over the other preparations. In the *pustular* forms, syphilitic rupia and ecthyma, the constitution being commonly shattered, a tonic plan of treatment is required in the first instance; after which the perchloride of mercury in tincture of bark or decoction of sarsaparilla should be steadily administered. In these cases also much benefit will be derived from the mercurial fume-bath. In the *tubercular* syphilide much the same treatment is required as in the last variety; in these cases, however, I have often found Donovan's solution of the greatest possible value, the disease rapidly disappearing under its use; the same plan is required in the management of syphilitic *boils*. In the treatment of secondary syphilitic *ulcers*, we shall find it necessary to use caustics freely, with the view of setting up a new and more healthy action in the part. For this purpose nitric acid, or the acid nitrate of mercury, is especially serviceable; on the separation of the slough thus produced, the sore may be dressed with red precipitate powder or ointment, or the black wash, to which, if there be irritation, opium may be added—the same constitutional treatment, especially Donovan's solution, being employed. Iodoform and paste of iodide of starch are valuable applications in the dirty-looking sloughing ulcers of syphilis. After a few applications, the ulcers become clean and healthy, and speedily heal. In syphilitic *alopecia*, the internal administration of perchloride of mercury with bark or iron, and the external use of a strong stimulant, such as the nitrate of mercury ointment or tincture of cantharides, will be found most serviceable; and in syphilitic *onychia*, the free application of nitrate of silver, followed by the black wash, and perchloride of mercury or Donovan's solution internally, is the proper treatment.

2. **Warts, Excrescences and Vegetations** are commonly met with in constitutional syphilis, especially in the neighborhood of the mucous canals, being usually situated in the neighborhood of the anus, perinæum, or scrotum; and in the female, upon and within the labia. They are also very frequently met with about the tongue, on the tonsils, palate, and lips. When occurring in the neighborhood of the organs of generation, they are usually large, flat, soft, slightly elevated, and uniform in structure and appearance, moistened with a good deal of mucous exudation, and a sort of perspirable secretion of the neighboring skin. When seated in the mouth or throat, they are usually small, and not so distinctly elevated or circumscribed, but look rather like a thickened and opaque condition of the mucous membrane in these situations. These secondary warts, *Condylomata* or *Mucous Tubercles*, as they are often termed, differ essentially from the primary vegetations, not only in their appearance and general uniform character, but in being dependent on the constitutional nature of the disease, and not on local causes solely, such as the irritation of discharges and the want of cleanliness. They are also certainly contagious; and I have known many instances in which they have been distinctly transmitted in this way; and, indeed, it is by and through them that secondary syphilis is transmitted from one individual to another, without the evidence of an antecedent primary

sore. Their *Treatment* must be constitutional as well as local; the constitutional means should consist in the administration of the perchloride of mercury with sarsaparilla; and the best local treatment with which I am acquainted is to rub them freely with the nitrate of silver, dressing the parts in the interval of the application with chlorinated lotions. Not being pendulous or distinctly protuberant, they do not, like the primary excrescences, require excision.

3. The **Mucous Membranes** *of the Mouth*, *Nose*, *Pharynx*, and *Larynx*, are commonly affected with secondary syphilitic eruptions which assume the form of mucous tubercles, or of the exanthematous, tubercular, and ulcerative syphilides. The *exanthematous* affection, corresponding to the roseolar form of cutaneous syphilis, and arising from the same cause and in the same constitution, principally affects the palate and throat. The *tubercular* variety corresponds to the squamous cutaneous eruptions, and is chiefly met with as flat, hard, and elevated tubercles in the interior of the mouth, nose, and throat. The *ulcerative* affection of the mucous membranes assumes a variety of forms, which will immediately be described, and occurs principally in the throat and nose. The exanthematous affection of the mucous membrane is usually an early sign of constitutional syphilis, frequently showing itself a few weeks after the primary occurrence of the disease. The other varieties belong to the more advanced secondary or tertiary periods.

The syphilitic affections of the mucous membranes so readily extend to, and are so commonly associated with, corresponding disease of the deeper structures, that we shall more conveniently consider their different forms according as they affect distinct organs or parts of the body.

The *Lips* are commonly affected in persons laboring under squamous syphilide, with fissures or cracks usually somewhat indurated, and very painful in the movement of these parts. In the *Treatment*, the application of a pointed piece of nitrate of silver to the bottom of the crack will give the most effectual relief. The insides of the cheeks are not unfrequently affected in a similar manner, or become the seat of mucous tubercles, which must be treated as has already been stated.

The *Tongue* may be affected with syphilis in various forms; when severely, its disease usually constitutes one of the tertiary varieties of the affection. In many cases the mucous membrane becomes thickened, but preserves a peculiar glossy, semi-transparent, almost gelatinous appearance, and, being irregularly fissured, gives the organ a thick and misshapen look. In other instances, the epithelium is dry, white, and opaque in patches; the surface of the tongue looking as if it had been dyed white here and there. Occasionally, ulcers form upon its surface or sides; these are usually irregular in shape, with a foul surface and a good deal of surrounding induration, and, unless care be taken, may readily be confounded with scirrhous or epithelial cancer of the organ. The diagnosis of these affections we shall consider when speaking of diseases of the tongue generally. Occasionally, a hard elevated circumscribed tumor of a dark-red or purplish color slowly forms towards the centre of this organ; it increases without pain and in a gradual manner, and principally occasions inconvenience by its bulk and the impediment it occasions in the movements of the tongue These various diseases usually indicate a deeply seated constitutional affection of the tertiary type. But some of the most obstinate cases that I have met with appeared to have originated from direct contact of the tongue with the same organ in another person the subject of tertiary lingual syphilis, and thus from direct contamination. The *Treatment* consists in the

administration of mercury, in the form either of iodide or of perchloride. Donovan's solution is extremely useful in many of the more inveterate of these cases. The ulcers should be touched from time to time with the nitrate of silver.

The syphilitic diseases of the *Throat* are amongst the most common manifestations of constitutional syphilis, and frequently occur early. They present several distinct forms, corresponding to analogous primary and secondary cutaneous affections. One of the earliest conditions is a deep-red exanthematous efflorescence of the soft palate and the pillars of the fauces, either without ulceration, or with but superficial abrasion, but with much cachexy and depression of power, and perhaps with considerable pyrexia. It often occurs about the period of the invasion of the roseolar or rupial syphilide, and requires the same *Treatment* as is necessary in these affections, together with the local application of a strong solution of the nitrate of silver. A deep excavated ulcer, with a hard base and foul greyish surface, of circular or oval form, is not unfrequently met with on one or the other tonsil; it corresponds to that class of secondary phenomena that follows the indurated chancre, and requires mercury in some form for its cure; in this and many other cases, the mineral may most conveniently be applied to the throat by means of fumigation. A sloughing ulcer is occasionally seen on the side of the throat or palate, with much swelling, a foul grey surface, and rapid destruction of parts, giving rise very commonly to perforation of the soft palate, and thus, by partially destroying the curtain between the mouth and the nose, occasioning serious inconvenience to the patient during deglutition and in speech. This form of ulcer is connected with the rupial or ecthymatous syphilides, and requires the same constitutional *Treatment* as these. The best local plan is free sponging with strong nitric acid, and gargling with solutions of the chlorides. More rarely a form of the serpiginous ulceration is met with, producing considerable contraction and inconvenient consolidation of tissues after its cure. It is, I think, best treated by the local application of nitric acid, and the internal administration of perchloride of mercury.

The mucous membrane of the *Larynx* is not unfrequently affected both in early and in advanced syphilis. During the period of the scaly eruptions on the skin, and excoriation of the fauces, the larynx is attacked by catarrhal inflammation and by the formation of flat slightly elevated papules, similar to those seen on other parts of the body. The symptoms are hoarseness and loss of voice, and occasionally cough. They usually subside without leaving any permanent injury. In these cases, chronic inflammation, with thickening and ulceration, takes place about the rima glotidis, with the general and local symptoms of chronic laryngitis: such as huskiness of voice, cough, and expectoration of tenacious or offensive mucus; a difficulty in deglutition, and a tendency to choking on swallowing liquids, with tenderness on pressure about the throat, also come on. These cases are usually accompanied by much constitutional cachexy, and not unfrequently terminate fatally by the sudden supervention of œdema glottidis. The *Constitutional Treatment* must depend upon the concomitant symptoms and the general state of the patient; most commonly tonics will be required. The *Local Means* consist in the free application of the solution of the nitrate of silver to the rima glottidis, and the occasional employment of counter-irritation. In syphilitic ulceration occurring about the sides or base of the epiglottis, care must be taken in the application of the stronger escharotics, such as nitric acid or the acid nitrate of mercury; as a small quantity of these, if inhaled

into the larynx, might produce serious difficulty in breathing, or even fatal asphyxia. In many cases it may become necessary to open the windpipe, in order to prevent death from asphyxia; this must be done in accordance with the rules that will be laid down when treating of Chronic Laryngitis.

The *Nose* is commonly affected in constitutional syphilis, and often destructively so, especially in individuals much exposed to changes of temperature, and who are unable to pay proper attention to their treatment. The mucous membrane becomes chronically thickened, with discharge of blood and pus, coryza, and habitual snuffling. In other cases ulceration takes place, with a very fetid odor of the breath, and the formation of thick ecthymatous crusts on the septum, or between this and the alæ. This ulceration is very persistent and troublesome, and requires usually a mercurial treatment with the local application of strong nitric acid, or of the acid nitrate of mercury, to arrest its progress. In many cases ulceration will rapidly proceed to destruction and perforation of the septum, or necrosis of the spongy bones, the vomer, and ethmoid; sometimes excavating the whole of the interior of the nose, scooping and cleaning it out into one vast chasm. When this happens, the nasal bones also are usually flattened, broken down, and destroyed; the alæ and columna ulcerating away, and producing vast disfigurement. Occasionally the disease extends to the bones of the base of the skull, and in this way may occasion impairment of vision, epilepsy, or death. The *Treatment* of these nasal affections must be conducted in accordance with general principles. In many cases mercurial fumigation is extremely useful; in others, where the disease is ulcerative, the strong acid and caustic applications already mentioned, with chlorinated solutions occasionally sniffed up, will do much to stop its progress. As necrosis occurs, the dead bone must be removed.

4. **Syphilitic Iritis** usually occurs after exposure to cold, and often in people who are otherwise strong and healthy. The ordinary symptoms of iritis, somewhat modified, characterise the affection. The patient complains of dimness of sight, pain in the eye, and often of very severe circumorbital or hemicranial pains. On examining the eye, the conjunctiva will be found to be slightly injected, and a zone of pink vessels to be seated on the sclerotic, close to the cornea; the aqueous humor has lost its transparency, giving a muddy look to the eye, and the color of the iris is altered. The pupil is diminished in size and irregular in shape, usually angular towards the nasal side, and small yellowish or brownish nodules of lymph may be seen to be deposited on the surface of the iris. If the case be left to itself, or be improperly treated, it will advance to disorganisation of the globe, and to permanent loss of sight. The retina often becomes affected, and incurable blindness results.

The *Treatment* consists in local depletion by means of cupping and leeches to the temples, and the administration of calomel and opium internally, at the same time that a strong solution of atropine is put frequently into the eye. Most commonly, as the mouth becomes affected by the mercurial, the eye will clear, the lymph becoming absorbed, and the pupil regaining its normal shape and color. In some cases, however, a chronic inflammation continues; here the best effects result from the administration of small doses of perchloride of mercury, with repeated blistering to the temples: and, in a later stage, soda and bark may be advantageously given.

5. **Syphilitic Periostitis** or **Nodes** may occur on almost any of the bones; but the disease is most commonly met with on the tibia, the

clavicle, or the bones of the fore-arm. Some joints are also not unfrequently affected by it; the sterno-clavicular articulation and the knee-joint are especially often its seats. Nodes are indolent, elongated, uniform, and hard swellings, sometimes tender on pressure, and generally but little painful during the day; but at night the aggravation of pain is peculiarly marked, and constitutes perhaps the most distressing symptom. They consist of a thickening of the periosteum, with some plastic effusion within and underneath it, and occasional thickening of the subjacent bone; they may continue permanently or may terminate by resolution; they never suppurate, unless there be disease of the subjacent bone.

The *Treatment* consists, if there be much tenderness, in the application of leeches; if there be no great sensibility on pressure, but considerable nocturnal pain, blisters should be applied. When the nodes are in a chronic state, the tincture of iodine is an useful application. Nodes sometimes become soft and prominent, and feel semi-fluctuating, especially when seated on the cranium, so as almost to tempt the Surgeon to make an opening into them; this, however, should never be done, as the swelling, however great, will subside under proper treatment. For the ultimate removal of the tumor, and the relief of the nocturnal pains, we possess an excellent and sure remedy in the iodide of potassium, carried to large doses.

Other fibrous membranes besides the periosteum may become diseased, and masses of dense lymph, in the form of warty tumors, excrescences, or nodes, may be deposited upon them as the consequence of the syphilitic inflammation. This is particularly the case with the dura mater of the brain and cord. As one of the ulterior effects of tertiary syphilis, structural changes of this kind may take place in and upon the dura mater of the brain, giving rise to hemiplegia and epileptiform seizures, and eventually coma and death, partly from pressure, partly from irritation. If the dura mater of the cord be affected by nodes, more or less complete paraplegia will result.

6. **Diseases of the Bones** are amongst the more remote and severe effects of constitutional syphilis, when it has reached the tertiary stage. By some Surgeons they are said to be the result of the administration of mercury, rather than of the syphilis for which the mineral is given. This doctrine I believe to be entirely without foundation. That they are met with in syphilitic cases in which no mercury has been given, there can be no doubt. I have had under my care patients with extensive disease of the cranium and of the clavicle, whose syphilis had been treated from first to last on the non-mercurial plan. One patient especially, a soldier, from whom I removed a portion of the cranium and of the clavicle for necrosis accompanying constitutional syphilis, had been treated in a military hospital without mercury. I have never seen or heard of mercury producing necrosis in any bones, except those of the jaws, when given for other diseases than syphilis. No doubt diseases of the bones are especially apt to occur when the patient's constitution has been broken down by any means; and an improperly conducted mercurial course may have this result. They usually occur after the patient has passed through the whole course of the less severe syphilitic affections, such as those of the skin, mucous membrane, and throat. The affections of the bones, however, may in some cases declare themselves at the same time with the affections of the skin and mucous membranes. They more commonly occur amongst the poorer classes,

especially those who are exposed to atmospheric vicissitudes, and chiefly in strumous constitutions.

The syphilitic affections are principally met with in those bones that are flat and compact, as the cranial, nasal, and maxillary bones. In these, various forms of disease occur. One of the most common is perhaps *Chronic Ostitis*, with hypertrophy and condensation of the osseous tissues, often to a very marked extent. This affection may occur in the bones of the skull, but is also met with in some of the long bones, as the tibia and the ulna; it is characterised by very severe pain, especially of a nocturnal character, accompanying the enlarged and thickened state of the bone.

Syphilitic Necrosis chiefly occurs in the bones of the skull and jaws, the alveolar processes of which may exfoliate; the palatine process of the superior maxillary bone, the spongy and the nasal bones, are also commonly destroyed by this morbid action; but it is a remarkable fact that the palate-bones are not nearly so often affected as the nasal and spongy bones. In consequence of this destruction of body tissue, the interior of the nose becomes chronically diseased, and the organ may fall in, or a communication may be established between the nose and the mouth through the hard palate.

Syphilitic Caries, or ulceration of bone, presents different forms, which, according to Stanley, correspond to analogous ulcers and eruptions of the skin. Thus, there may be the *simple ulcer* of the bone, showing a rough, irregular, porous, and depressed surface; the *worm-eaten caries*, consisting of small pits or excavations, studding the surface; and the *serpiginous* or *creeping ulcer*, marked by imperfect attempts at repair, and the deposition of new bone in nodules or masses. The cranial bones are those that are most commonly affected in this way; and their disease may sometimes prove fatal by the irritation set up by it in the brain or its membranes. The bones of the extremities, however, are not unfrequently similarly affected.

I have twice seen a peculiar *dry caries* of the cancellous structure of the head of the tibia in old syphilitic cases. In both cases, which were very similar, the patients had been affected for a length of time with nodes of the tibia, as a consequence of long antecedent syphilitic taint. Chronic abscess eventually developed itself over the head of the tibia, leading to carious bone. I exposed this and gouged it away. It was peculiarly dry, light, and almost flocculent, if such a term can be applied to bone. Both patients recovered well from the operation; but one of them, a female, died two years afterwards of epilepsy, consequent on syphilitic tumors of the dura mater.

The *Treatment* of syphilitic disease of bone varies somewhat according to the form which it assumes, and the previous management of the patient. In *ostitis*, the principal reliance should be placed upon the conjoined influence of calomel and opium, provided the patient have not previously been fully mercurialised. If he have been so, we must rely chiefly upon iodide of potassium. In the more advanced and intractable cases that have resisted all treatment, I have found the greatest advantage result from cutting down upon the enlarged, thickened, and tender bone, and by means of a Hey's saw making a deep cut into it about one and a half or two inches in length parallel to its axis, and down to the medullary canal. By this operation the tension is at once relieved, and the pain effectually and permanently removed. In syphilitic *necrosis*, the constitutional cachexy demands the principal share of attention; the necrosed bone should be separated as it becomes loose, the local irrita-

tion depending on its presence then subsiding. When the bone has fallen into a *carious* state, iodide of potassium in combination with iron, cod-liver oil, or sarsaparilla, with the mineral acids, will improve the tone of the system, and stay the progress of the disease. The ulcerated and exposed bone requires to be dressed with strong stimulants; the red oxide of mercury, in ointment or powder, is perhaps the best; in some cases, touching the part freely with the acid nitrate of mercury will establish a more healthy action.

7. Besides these various constitutional manifestations of syphilis, tumors of the **Muscles and Tendons**, depending on this disease, have been described by Bouisson. These consist of nodules of yellow gummy matter, like those described as occurring in the testis; they form between the muscular fibres from the connective tissue. The muscles are also often contracted by tough adhesions of the sheaths and insertions through slow inflammation and thickening of the fibrous tissue. When affecting the tendons, these tumors are elongated, and resemble nodes upon them. Their presence is attended with some pain during the contraction of the muscle; they are usually somewhat globular, and vary in size from a nut to a pigeon's egg, being accompanied by nocturnal pains. They are best treated by the iodide of potassium in large doses.

8. **Syphilitic Disease of the Testicle** is one of the more advanced conditions of the constitutional affection. It commonly occurs as the result of that train of symptoms that consist mainly of squamous affections of the skin, the excavated ulcer of the throat, iritis, and nodes, but usually it does not appear until these different manifestations of constitutional syphilis have, each in its turn, passed away; the patient, indeed, appearing to have recovered from all disease, and being otherwise in good health. Commonly the exciting cause of the disease may be a blow, a squeeze, the occurrence of gonorrhœal epididymitis, or some other local cause. The testis then gradually enlarges, until it attains the size of a turkey's egg, or even larger, being ovoid in shape, heavy, and smooth, not painful except by its weight, which causes dragging and uneasy sensations in the cord and loins. This disease is very commonly accompanied by a small hydrocele, constituting, indeed, a hydrosarcocele. Most frequently only one testis is affected; very rarely both are diseased. The affection continues to increase, giving rise to uneasiness from its size and weight, but is not followed by suppuration or other inconvenience.

Hamilton of Dublin has described another form of syphilitic sarcocele, under the term "tubercular syphilitic sarcocele." In this the testis is enlarged to three or four times its natural bulk, of an irregular shape, presenting an uneven, hard, and knotty mass; it is neither painful nor tender, but inconvenient from its weight, causing pains in the loins and cord. Both testes are usually affected, but one is worse than the other; and when the disorganisation is great, Hamilton states that all sexual desire is lost, and that neither erections nor emissions take place; both however, returning as the treatment effects the restoration of the organ to its normal condition. In these cases suppuration not unfrequently takes place, followed by the discharge of thin pus, the formation of fistulous openings, and occasionally the protrusion of a fungus. This form of sarcocele occurs in persons of a broken and cachectic constitution, who are suffering severely from the more advanced and inveterate forms of tertiary syphilis, especially of the bones and throat.

In the simple syphilitic sarcocele, the enlargement of the testes is principally due to the deposit of semitransparent white or yellow lymph,

in an uniform manner, throughout the substance of the organ external to the tubuli. In the tubercular syphilitic sarcocele, Hamilton states that tubercles of a yellow color, and varying in size from a split pea to a chestnut, or even larger, are found in the substance of the organ; these softening, give rise to suppuration in and around them, and thus to the ultimate disorganisation of the testis, which becomes converted into a hard irregular fibro-cellular mass, in which cretaceous matter is occasionally deposited.

In the *Treatment* of the simple form of sarcocele, a full mercurial course is generally necessary; the perchloride, in doses of the twelfth or eighth of a grain three times a day is the best preparation. This should be continued for at least six or eight weeks, or until hardness disappears. Any hydrocele that exists should be tapped, and the fluid drawn off by means of a small trochar and cannula before the treatment is commenced. After the mercury has been discontinued, the remaining swelling of the testis may be removed by the internal administration of iodide of potassium in five-grain doses, twice or thrice daily, with frictions with the iodide of lead ointment. In these cases, care should be taken not to irritate the scrotum with very stimulating applications, as the skin is tender, and readily becomes excoriated; ordinary strapping is of very little use, but in some cases I have found strapping with the plaster of ammoniacum and mercury, diluted with equal parts of belladonna plaster, of service. If suppuration occur, and a fungus protrude, the same treatment must be adopted as will be described in speaking of the strumous testicle.

9. **Syphilitic Ovaritis** is a disease that I believe I have on several occasions met with. The history of the cases has been uniformly as follows: a long antecedent attack of syphilis; various constitutional symptoms running through secondary and tertiary stages; inflammatory congestion of one ovary, as determined by abdominal and rectal exploration; eventual cure by means of leeching and the perchloride of mercury and bark;—in fact, a condition of things closely resembling what occurs in syphilitic sarcocele

10. **Visceral Syphilis.**—Our knowledge of the syphilitic diseases of the internal organs is of modern origin, and still somewhat imperfect. "Visceral Syphilis" was not only unknown to, but unsuspected by, so acute an observer as John Hunter, and the syphilographers of the early part of this century make no mention of it. To Dittrich, Lancereaux, Wilks, Bristowe, and Moxon, we are indebted for the establishment of the fact that, after external manifestations of syphilis have in a great measure, if not entirely, disappeared, and the disease has entered its tertiary stage, gummata may form in most, if not in all, the internal organs, producing serious functional disturbance, and leading to organic changes of the most extensive, deep-seated, and fatal character.

It may now be taken as a fact, incontestably established by numerous pathological observations, that there are few, if any, organs that escape the ravages of syphilis; and although there may be a doubt whether some of the forms of disease met with in certain organs, as the liver, lungs, and spleen, and described as syphilitic, may not in reality be due to non-specific disease, to which, as well as to syphilis, they are common, there can be no doubt of the fact, as Moxon has pointed out, that when gummata are met with in internal organs the fact of the syphilitic nature of the disease is established.

In the *heart*, syphilitic deposits have been found on the endocardium, less frequently in the valves; and two forms of myo-carditis of syphi-

litic origin—one circumscribed, the other diffuse—have been described by Lancereaux. The *arteries* are very apt to undergo syphilitic degeneration, according to the same author, those of the neck and head more especially. But in any portion of the arterial system fibroid deposits of syphilitic origin may be met with, leading by their degeneration to aneurism. The syphilitic arterial deposits must not be confounded with ordinary atheroma. They may occur either as infiltrations into the coats, or as deposits of semi-opaque plastic matter in the lining membrane of the vessels.

The *lungs*, *liver*, and *spleen* are all liable to syphilitic deposits. As a general rule, they may affect two forms—occurring either as a gummata or as diffuse interstitial deposit, which in the liver may simulate cirrhosis, and in the lungs some of the forms of "fibroid phthisis." These syphilitic visceral diseases not unfrequently run a fatal course: rarely, however, destroying the patient before the age of 35 (Wilks). The diagnosis of the specific nature of the affection must always be open to doubt, except in those cases in which the history of the affection has been continuous, and some of the more superficial and easily recognisable syphilitic affections are associated with the visceral forms of the disease. So far as treatment is concerned, there is little hope from any remedies except the mercurial.

11. There is no more distressing form of syphilitic disease than that which affects the **Nervous System**. The brain, the spinal cord, and their meninges are all liable to this invasion; but we have no evidence as yet that the substance or the neurilemma of individual nerves may become the seat of the disease, although that such may be the case is in the highest degree probable.

Syphilitic disease of the nervous system may occur at all ages. It is common in young men. I have often seen it under or about the age of 25 to 30. It is the common cause of paralysis in early manhood. The paralytic condition, which is one of its earliest manifestations, is very commonly developed by some slight accident—a fall upon or a strain of the brain, or by over-exertion in walking, riding, or running. The primary syphilitic disease has often been slight—the secondary symptoms trivial; and indeed, no great importance may have been attached to the venereal infection, until the manifestations of its most terrible and destructive effects on the brain or cord.

The great peculiarity of the nervous affections dependent on syphilis is that they are irregular, scattered, and do not follow the ordinary course of the non-specific forms of the disease. They are commonly accompanied by cutaneous syphilides of the low types, such as ecthyma, rupia, or serpiginous sores; by occasional sloughy throat; by painful nodes on the cranium, vertebral column, or long bones; and the final manifestation of the nervous affection is very often preceded by severe pains in the head, down the limbs, or round the body.

The disease may declare itself in two forms, separately or conjoined: viz., by paralysis or epilepsy.

Syphilitic Paralysis chiefly affects the motor nerves. The third, fourth, sixth, and seventh are often early affected, giving rise to ptosis, to immobility of the eyeball, or to strabismus, with more or less facial palsy and double vision. I have never seen paralysis of the fifth nerve in the disease. Oculo-motor paralysis in some form is, indeed, one of the earliest signs of a syphilitic disease of the brain, and when this occurs in young men it should, however passing and slight, always attract the

most serious attention, as it is usually the precursor of more general paralytic disease.

If the patient be hemiplegic, he is only partially so, and the hemiplegic affection is irregular in the intensity of its distribution, in the degree of loss of motor or sensory power in different limbs, and is often spastic.

When the spinal cord or its membranes are the seat of the syphilitic disease, the lower segment of the cord is usually first or more markedly attacked.

Paraplegic symptoms to a limited extent often show themselves. They usually commence in the muscles supplied by the external popliteal nerve, and are often throughout the course of the disease confined to these, giving rise to dragging of the foot, and inability to raise it from the ground, or to turn it outwards.

Epileptic Seizures are common in the cerebral form of syphilis. They are often of the most prolonged and violent character, leading to coma. But dangerous as these attacks may become, there is this remarkable point in connection with them—that epileptic seizures of the gravest possible character, if syphilitic in their origin, may be recovered from, whilst attacks of equal severity, if non-specific, would certainly have a fatal termination. After these epileptic attacks the patient often improves materially, some of his paralytic symptoms, such as ptosis or strabismus, being ameliorated or even passing away entirely. In other cases, again, the mental powers undergo gradual deterioration, delusions perhaps manifest themselves, and the patient falls into a state of semi-imbecility.

There is truly not a more pitiable object to be seen than a man, young or in the prime of life, suffering from syphilitic disease of the nervous centres—affected by ptosis—with one eye staring and immovable or squinting, the face distorted, the lip dropped and saliva dribbling, defective in his articulation, straddling and insecure in his walk, dragging one leg behind him. At times the victim of the most frightful epileptic paroxysms, often covered by rupial sores, he is truly a fit object for commiseration rather than one for reprobation and reproach.

In syphiloma of the brain, *post-mortem* examination usually reveals gummata with softened cerebral tissue around, adherent and opaque membranes, degenerated cerebral arteries. In the cord, syphiloma appears in the form of small scattered gummata, usually about the size of barley-corns. In one case (Wilks) the deposit was as large as a nut. These deposits have chiefly been met with in the lower half of the cord. The membranes may be thickened by gelatinous deposits, adherent and injected.

In the *Treatment* of these cases, if not too far advanced, there is fortunately much to be done for the patient's relief, if not complete cure. Mercurials in some shape—more especially the perchloride or the green iodide—if not previously fully used, should have a fair trial given. The iodide of potassium in gradually increasing doses should be given, especially in those cases in which mercury has been fully employed or in which there is much periosteal thickening and tenderness. In such cases also, counter-irritation by means of blisters and setons will be found useful. And lastly, the epileptic paroxysms may be controlled by means of the bromides of potassium or of ammonium. But it must be evident that, when once the affection of the nervous centres has developed gummata of large size, no treatment can be of much avail, and destructive disorganization of the substance of the brain or cord must eventually result.

INFANTILE SYPHILIS.

Chancres on the libia of the mother may possibly infect the child at birth with either of the two forms of venereal disease that have been described, just as they may inoculate the hand of the accoucheur; but syphilis thus contracted by the infant is not the form of the disease that is described as **Infantile Syphilis.** This is a truly hereditary infection, transmitted to the infant at the time of its conception, or communicated to it through the medium of the mother during intra-uterine life, and existing as a constitutional affection at the time of its birth. Though we may believe that syphilis is not easily eradicated from a system into which it has once been received, and that under certain conditions it may readily be transmitted to the offspring; yet I think that we are still ignorant of the amount and nature of the constitutional affection of the parents that are necessary for the development of syphilis in their children, and that we are certainly not warranted in concluding that a parent who has been, or even who is actually affected by constitutional syphilis, must necessarily have a syphilitic, or even a feeble and strumous family; although the probability undoubtedly is that the offspring will be syphilitic. I have had under my observation a gentleman whom I had attended for secondary syphilis, and who, contrary to my advice, married some years ago; and, though has since then suffered from psoriasis of the hands, mucous tubercles, fissures on the lips and tongue, and venereal sarcocele, yet his wife has borne a perfectly healthy family, not only without any syphilitic taint, but without any apparent constitutional cachexy.

When the ovum is infected with syphilis, several morbid states may result, according to the intensity of the infection. It may be so blighted that it never reaches the maturity of intra-uterine life, but becomes early aborted; in this way many consecutive miscarriages may happen in consequence of one or both parents having constitutional syphilis; but, if they be put under proper treatment by a mercurial course, and the disease be thus eradicated from the system, the ovum will at the next pregnancy probably reach its full development. Gestation may go its full time, and the fœtus be born with syphilitic cachexy and local manifestations of the disease fully developed upon it. More frequently, however, the child, although cachectic and sickly looking, is brought into the world without any syphilitic appearances; but in the course of a few weeks, usually from the third to the eighth, these declare themselves. Constitutional syphilis of a congenital nature may manifest itself even at the adult age. This, though rare, has fallen under my observation in a young woman aged seventeen who was covered with marked syphilitic psoriasis, with which she had been affected for several years. The mother told me that, shortly after birth, evidences of infantile syphilis had appeared; that these had yielded to treatment, but that, as the period of puberty approached, the psoriasis, which was truly of a syphilitic nature, had shown itself. In other cases, again, it is not impossible that the syphilitic taint may manifest itself in a different way from that which has just been alluded to; that no local manifestation may occur, but that an impaired and depraved state of constitution and of nutritive activity may be inherited, which, in after-life, gives rise to some of the various forms of scrofula or of other constitutional disease, dependent upon an enfeebled state of system, or a diminution, as it were, of the general vitality.

Mode of Communication.—The mode of communication of syphilis to the ovum, or to the fœtus in utero, is an investigation that has much

occupied the attention of Surgeons, and is of considerable practical interest. It has been considered probable, that the poison may be communicated to the embryo in at least four ways: *viz.*, 1, the father may have a constitutional taint of which he has been imperfectly cured, and without communicating any syphilitic disease to his wife, may be the parent of an offspring that exhibits indications of being infected; or, 2, the mother, having a similar constitutional disease, may in like manner taint her own offspring; or, 3, the diseased child may be born of parents, both of whom are constitutionally infected; or, 4, the mother may become pregnant with a healthy embryo, but, afterwards, contracting syphilis, may transmit it to her offspring.

There are very good reasons for believing that the disease does not pass from the father to the child without also implicating the mother. In the first place, this faculty is shared by no other contagious disease. No father can give his offspring small-pox, though the mother frequently communicates that disease to her fœtus. In the next place, it is well known, as Colles of Dublin long ago pointed out, that a congenitally syphilitic child never locally infects its mother, though it will transmit its disease readily to a wet-nurse, whose breast it sucks; this apparent exemption of the mother being due to the fact that she has been already infected. Again, the symptoms of syphilis are often exceedingly mild in women, and constantly overlooked. Hence, in the present state of our knowledge, it is safer to conclude that the father infects the mother, and that she transmits her disease to the offspring.

Ricord, however, states that a mother, pregnant with a syphilitic fœtus, the offspring of a father laboring under constitutional disease, can be infected through it without herself having had primary syphilis; and Jonathan Hutchinson has advanced a considerable amount of evidence in support of this doctrine, which, nevertheless, fails to carry conviction to my mind that such communication ever takes place. Then, again, there is no doubt that a wet-nurse laboring under constitutional syphilis can infect the child that she suckles, the infant being contaminated through the medium of the milk. Ricord, and many others of equal authority, admit this. My own opinion is that syphilis is, though rarely, so transmitted; and, indeed, there are a number of cases on record in proof of this (*vide Ranking's Abstract*, vol. iv.). The converse of this is also a matter beyond dispute: a syphilitic child can infect a healthy nurse. This point is one of very great importance, inasmuch as actions for damages have been brought by women who have stated that they have become diseased from the child that they have nursed. There are cases recorded that prove it incontestably; and, on such a question as this, one positive fact must necessarily outweigh any amount of negative evidence. Not only have Hunter and Lawrence related cases in which an infected child communicated the disease to several nurses in succession (in Hunter's cases three wet-nurses were successfully infected, two of whom gave the disease again to their own children), but a considerable mass of evidence upon this point is to be found in *Ranking's Abstract* (*loc. cit.*). The disease is especially apt to be communicated in this way, if the nurse have any crack or abrasion upon her nipple, and the infant sores on the mouth. Colles, however, who had great experience in syphilis, states that the disease may be communicated to the nurse from an infected child, by mere contact, without excoriation.

Symptoms.—The symptoms of infantile syphilis are sufficiently well marked: consisting principally of cachexy, with disease of the mucous and cutaneous surfaces. The first indication is usually the *atrophic and*

cachectic appearance of the child; this not infrequently shows itself at birth, and when it does so, such children are often small, shrivelled, wan, and wasted, when born; the face especially has an aged look, the features being pinched, and the flesh soft and flabby; the complexion generally has a yellowish or earthy tinge; and these characters continue until the disease is eradicated from the system of the child. But it is more usual for the disease to delay its appearance until a month has elapsed after birth. Diday and De Méric have collected a large number of cases, in most of which the disease was developed in the fifth and sixth weeks. Many betrayed their disorder in the first month; in some few it was delayed until the child had attained the age of three months. The earlier the disease shows itself, the more fatal are its effects. Children who are not attacked till they are two or three months old, usually recover their health in a short time. Nor, when the child is born with syphilitic eruptions, is it always atrophic and ill-nourished, though such a condition is the ordinary one.

The first local sign that declares itself is usually a congestive condition of the mucous membrane of the *nose*, giving rise to the secretion of offensive mucus, and causing the child to make a peculiar snuffling noise in breathing, as if it had a chronic catarrh; this snuffling may exist from the time of birth, but generally comes on very shortly afterwards. The mucous membrane of the mouth is also liable to attacks of inflammation, and this *syphilitic stomatitis* is a very marked characteristic of the disease.

The disease manifests itself upon the *cutaneous and mucous surfaces*, sometimes before or at birth, in other cases not until several weeks have elapsed. The most common period for the occurrence of these signs is the third or fourth week. The cutaneous eruption usually makes its appearance on the nates, the scrotum, the soles of the feet, and around the mouth; hence, in examining a syphilitic child, these parts should always be looked at first. It presents itself in three different forms: most frequently as flat tubercles, varying in size from a split pea to a fourpenny-piece, smooth, slightly elevated, and of a coppery or reddish-brown color. These tubercles are often accompanied by cracks and fissures about the mouth and anus. Though commonly called *squamous*, they are not in reality scaly, but are always smooth and flat. Intermixed with these are brownish maculæ or spots, differing in size, and variously figured.

The vesicular or bullous eruption is not so common as those just described, yet I have frequently seen it in syphilitic children. It appears in the form of vesicles, about the size of a split pea, with a dusky coppery areola and base; drying into brown scales or scabs, and commonly conjoined with the tubercular affection. These bullæ are most frequently seen on the soles of the feet.

When we consider the influence exercised by the syphilitic poison upon the skin, and its appendages the hair and nails, we should *à priori* have expected that the **teeth**, as a portion of the dermal skeleton, would participate in the morbid action induced by it on the allied structures. The fact of their doing so does not, however, appear to have attracted the notice of any observer, until J. Hutchinson directed the attention of the profession to this very interesting subject, and pointed out the destructive and special influence exercised upon the teeth by secondary constitutional syphilis. This injurious influence manifests itself both in the temporary and in the permanent teeth; but only with its specific and peculiar characteristics in the permanent set. It must not, however, be

supposed that in all cases of infantile syphilis the teeth are affected; indeed, in many instances they are not, and it has been particularly pointed out by J. Hutchinson that it is only when there have been attacks of syphilitic stomatitis, that we are to expect to meet with these changes in the teeth from their normal types.

The *temporary teeth* of syphilitic infants are cut early, are of bad color, and liable to a crumbling decay (Fig. 319). The upper central incisors usually suffer early, and always first; then the laterals become carious and drop out; and lastly, in some cases, though rarely, the canines wear away so as to present a tusk-like appearance. In consequence of the early decay of the incisors, children are often edentulous, so far as these teeth are concerned, from an early age, until the permanent ones are cut.

Fig. 319.—Syphilitic Temporary Teeth.

Fig. 320.—Two Central Syphilitic Incisors Deeply Notched (Hutchinson).

Fig. 321.—One Central Incisor Notched (Hutchinson).

The *permanent teeth* present the more marked characteristics of an inherited syphilitic taint; and in these, as in the temporary, the disease declares itself chiefly in the incisors of the upper jaw, and first in the central ones. These will be observed to be usually of a bad color, short, peggy, rounded at the angles, standing apart with interspaces, or converging, and marked by a deep broad notch. They are soft and crumbling, are slender, and readily wear down (Figs. 320, 321).

Besides the notching, the sides of the teeth are curved inwards towards one another, and thus the cutting edge becomes narrower than the crown. The teeth are also shorter than the others. The convergence of the sides causes the teeth to be somewhat separated, and to stand apart.

Under the name of **Chronic Interstitial Keratitis**, J. Hutchinson has described a disease which he believes to be uniformly due to hereditary syphilis. It occurs between the ages of 5 and 18, but may occur much earlier, even during the first year. It consists at first of a hazy condition of the cornea, giving it the appearance of ground glass, followed by vascularisation without any tendency to ulceration. The opacity commences in the centre, and both eyes are usually affected. The vascularity is not confined to the surface, but seems to pervade the whole thickness of the cornea. One eye is usually affected before the other. Under a carefully conducted course of mercurials and iodides,

accompanied by tonics and good diet, the transparency of the cornea can usually be restored.

Treatment.—The occurrence of syphilis in the infant may be *prevented* by putting the infected mother on a mercurial course so soon as her pregnancy is ascertained ; this indeed may be necessary in order to prevent miscarriage, but should be done cautiously, and by inunction rather than by mercury administered by the mouth. Should repeated miscarriages have occurred, as the consequence of constitutional syphilis, one or other or both the parents, if at fault, should be put upon a mercurial course ; and thus the recurrence of this accident may be prevented.

The **Curative Treatment** as regards the child is extremely simple. It should be brought up by hand, lest it infect the nurse or continue to receive fresh accession of poison from the diseased milk of its mother. It must then be put under the influence of mercury, which in these cases acts almost as a specific ; and, indeed, the ready manner in which all disease may be eradicated from the system of a syphilitic child by this mineral, is perhaps one of the strongest proofs that can be adduced of the specific character of its action on the venereal poison. The mercury may be given by the mouth in the form of small doses of hydrargyrum cum cretâ ; but, as it often purges the child when administered in this way, Brodie has recommended its introduction into the system by inunction, which process I invariably employ, and have found it a most successful mode of treating the disease. The most convenient plan is, as recommended by Sir Benjamin, to spread a drachm of mercurial ointment on the under part of a flannel roller stitched round the thigh just above the knee, and to renew this every day. The treatment should be continued for two or three weeks, until all rash and snuffling have disappeared, when, the mercury having been discontinued, the cure may be perfected by the administration of small doses of iodide of potassium in milk or cod liver oil. Occasionally the cutaneous manifestations of infantile syphilis are complicated with, and obscured by, some of the common diseases of the skin incident to early childhood ; more particularly with eczema impetiginodes of the head, face, and body. In these circumstances, the diagnosis may not be easy, though the history of the case, the concomitant appearance of two forms of the disease, and the existence of snuffling and cachexy, tend to establish it. The eczema also, in these circumstances, is browner and more squamous than usual. In cases such as these, the best plan is to treat the syphilitic affection first with the mercurial inunction, and then to put the child under a mild course of Donovan's solution, two or three minims for a dose, keeping it at the same time on a good nourishing diet.

DISEASES OF TISSUES.

CHAPTER XXXVII.

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES.

THE various specific cutaneous affections, such as eczema, scabies, impetigo, acne, lepra, psoriasis, &c., probably fall within the province of the Surgeon, and are commonly treated by him in practice; but, as the consideration of these diseases would necessarily lead into the whole subject of Dermatology, the limits of this work would not allow me to discuss so extensive and special a branch of Surgery; and I must therefore content myself with the consideration of some of those affections of the skin, which, as requiring manual assistance, may perhaps be more properly looked upon as within the scope of the present Treatise. These diseases may be considered under the several heads of Diseases of the Appendages of the Skin, as of the cuticle and nails; the Non-Malignant Ulcers of the Skin; and the Malignant Ulcers and Tumors of this tissue. We have already, in Chapter VI., considered the ordinary non-malignant ulcers of the skin, and in Chapter XXXIV. some of the simple tumors that occur in connection with this tissue; we shall here, therefore, only consider the *Diseases of the Appendages of the Skin*, and the *Malignant Ulcers and Tumors.*

DISEASES OF THE APPENDAGES OF THE SKIN.

WARTS consist of elongated papillæ, with strata of thickened and hardened cuticle, usually situated about the hands and face, and chiefly affecting young people; they appear in many cases to be simple overgrowths of the cutaneous structures, coming and going without any evident cause. In other cases they are more permanent, becoming hardened and dark in color, and continuing perhaps through life.

The *Treatment* of warts is usually sufficiently simple. As their vitality is low, they may be readily destroyed by the application of caustics or astringents; among the most useful of these I have found the concentrated acetic acid and the tincture of the sesquichloride of iron. Brodie recommends the solution of a drachm of arsenious acid in half an ounce of nitric acid. In some cases, they may be ligatured or snipped off with advantage.

CORNS usually consist of small thickened masses of epidermis, accumulated on those points on which undue friction or pressure has been exercised, in order to guard the subjacent cutis from injury. These epidermic masses are usually hard, dry, and scaly; at other times they are soft and spongy, when situated in places where the secretions of the skin accumulate, and keep them moist. Under old and very thickened corns, it is stated by Brodie that a small bursa is occasionally found; this bursa may suppurate, and become very painful. Corns are at all

times sufficiently painful, but become especially so if inflammation or suppuration take place beneath them; the accumulation of a small drop of pus under the thickened cuticle, which prevents its escape, giving rise to very intense agony. There is a special form of warty corn that I have seen only in the sole of the foot, and which may become the source of the greatest possible pain and inconvenience to the patient, preventing his walking, and in fact completely crippling him. This corn is usually of small size and round in shape, the neighboring cuticle being always greatly thickened and hardened. It is extremely sensitive to the touch, the patient shrinking when it is pressed upon, as if an exposed nerve had been injured. On slicing it down with a scalpel, it will be found to be composed of soft, tough, and white epidermis, arranged in tufts or small columns, in the centre of each of which a minute black dot is perceptible. Each tuft appears to be an elongated and thickened papilla, and the black speck is a small point of coagulated blood which has been effused into it. Around the depression in which each of these corns is seated, the hardened cuticle forms a kind of wall.

The *Treatment* of ordinary corns consists in shaving or rasping them down so as to prevent the deep layers of cuticle, retained by the indurated superficial ones, from giving rise to pain by pressure on the papillæ of the cutis. Relief may also be afforded by removing all pressure from bearing upon the corn, by attention to the shape of the shoe, and by wearing a piece of soft leather or of amadou, having a hole cut in the centre into which the corn projects. It is well to avoid the application of caustics to ordinary corns; injurious consequences being often produced by these agents, especially in elderly people, in whom fatal gangrenous inflammation, as I have seen in one case, may be excited by their action. If the corn suppurate, it must be poulticed and shaved down, and the drop of pus let out by puncture with a lancet.

The painful papillated corn of the sole of the foot is the only form of corn in which an escharotic can be safely used. I have found the application of potassa fusa, so as to destroy it thoroughly, to be the best and the speediest remedy; and, as this corn always occurs in young people, no danger attends its use.

Perforating Ulcer of the Foot consists in a sinus that traverses the foot between the metatarsal bones. It is unconnected with any disease of the osseous or articular structures, and occurs in otherwise perfectly healthy persons. The mechanism of the disease appears to be as follows. A hard corn forms on the sole; suppuration takes place under this; the pus is unable to escape through the indurated cuticle, and consequently travels upwards and finds an exit on the dorsum of the foot, through an ulcerated opening there. On passing a probe through this opening, it will impinge on the corn in the sole, in which perhaps there may be found a small perforation, allowing an imperfect discharge of pus. The *Treatment* consists in stimulating the interior of the sinus, and in providing an aperture in the sole of the foot for the escape of the pus. This is done by passing a seton of two silk threads through the sinus.

Diseases of the Nails.—The nails may become diseased, by undergrowing structural changes, by having their matrix inflamed, or by growing into the soft tissues of the toes.

In some broken states of health, and especially in persons suffering from squamous disease of the skin, the nails occasionally become blackish or dark-brown in color, are rugged, dry, and cracked, scaling off, as it were, without any apparent affection of the matrix. This condition,

of which I have seen several instances, is best cured by a course of alteratives and sarsaparilla, the disease yielding as the general health becomes improved.

Onychia is a disease of the nails dependent on inflammation of the matrix; it occurs under two forms, the *simple* and the *specific*.

In **Simple Onychia** there are redness, heat, and swelling, usually on one side of the nail, in the angle of the tissue in which it is implanted: there is discharge of pus, and the nail gradually loosens, becomes dark-colored, somewhat shrivelled, and may eventually be thrown off, a new nail making its appearance below, which commonly assumes a somewhat thickened and rugged shape. This disease usually results from slight degrees of violence, as the running of thorns and splinters into the fingers.

The *Treatment* consists in subduing inflammation by local antiphlogistics, poulticing, &c., and watching the growth of the new nail, which may be sometimes usefully directed by the application of a layer of wax.

Specific Onychia is a more serious affection, and is often dependent on injuries inflicted on the finger in a syphilitic or cachectic condition of the system. In it a dusky-red or livid inflammation takes place at the sides or root of the nail; ulceration is set up, accompanied by the discharge of sanious and very fetid pus; and large loose granulations spring up at its root and sides, so that the end of the toe or finger that is affected (and this is most commonly either the great toe, the thumb, or the index finger) becomes greatly enlarged and bulbous in shape. The nail then shrivels, becomes brown or black, and peels off in strips (Fig. 322); after its separation, thick epidermic masses, forming abortive attempts at the production of a new nail, are deposited at the base and sides. In the *Treatment*, both local and constitutional means are required. The first and most essential point is to *remove the nail*, either in whole or part, as it acts as a foreign body, and prevents the healing of the surface from which it springs: the ulcer may then be treated with iodoform or well rubbed with the nitrate of silver, and dressed with black wash. Colles recommends fumigating it with a mercurial candle, made by melting a drachm of cinnabar and two ounces of white wax together. The *constitutional treatment* consists of means calculated to improve the general health; with this view Sir A. Cooper recommends calomel and opium. I have generally found bichloride of mercury, with sarsaparilla or cinchona the most useful remedy.

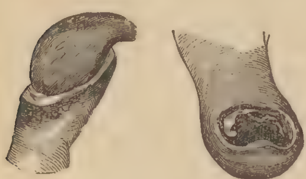


Fig. 322.—Syphilitic Onychia.

Ingrowing of the Nail is an extremely painful and troublesome affection, principally occurring in the great toe, and brought about by wearing pointed shoes, by which the sides of the soft part of the toe are pressed upon, and made to overlap the edge of the nail. An ulcer here forms, the liability to which is greatly increased by the nail being cut square, so that the flesh presses against a sharp and projecting corner of it; this ulcer secretes a fetid sanious discharge, and large granulations are thrown up by it. The consequence is inability to walk or even stand with comfort.

Treatment.—Various plans have been devised with a view of raising the edge of the nail, partially removing it, and pressing aside the soft structures. I have never, however, seen much permanent benefit result

from any of these means; and the only method that is, I think, really serviceable to the patient, is the removal of the whole nail. As this operation is an excessively painful one, the patient should be anæsthetised with nitrous oxide, or the matrix should be rendered insensible by the ether-spray. The Surgeon holds the diseased toe in his left hand, and running one blade of a strong sharp-pointed pair of scissors under the nail up to its very root, he cuts through its whole length, and, removing the scissors, seizes first one half and then the other with a pair of dissecting forceps, and twists them away from their attachments. The raw surface left is covered with water-dressing, and speedily throws out granulations which form the rudiments of a new nail. The new nail usually grows straight and healthy. In some rare cases, however, I have seen a faulty direction assumed by it. Avulsion of the toe-nail is usually unattended by danger. I was, however, once called upon to amputate a foot for gangrene, which had followed the operation performed on an elderly person.


Fig. 323.—Hypertrophy and Deformity of Toe-nail.

Hypertrophy of Toe-Nail.—Occasionally from neglect the toe-nail may become enormously hypertrophied and twisted, looking more like a horn than a nail, as in the accompanying drawing (Fig. 323), taken from a patient in whom the nail had been allowed to grow uncut for twenty years, producing complete lameness. I removed the nail whole by avulsion, and a sound and useful foot resulted.

TUMORS AND ULCERS OF THE SKIN.

Cheloid and Fibro-vascular Tumors of the skin are semi-malignant growths situated on the trunk and extremities, usually flat and expanded, oval, round or irregular in shape, slightly elevated above the surface of the skin, and commonly occurring in otherwise healthy individuals. They may remain stationary for years, but not uncommonly have a tendency eventually to ulcerate, to bleed, and to assume a sort of malignant action; at other times they extend slowly, without ulceration, moving forwards as it were upon the skin, the part over which they have passed assuming much the appearance of the cicatrix of a burn, being red, contracted, drawn in towards the centre, and wrinkled. Closely allied to these are those fibro-plastic growths that have a tendency to sprout up in scars, constituting the **Warty Tumors of Cicatrices**, described by Cæsar Hawkins. This morbid condition appears to be simply an abnormal increase in the activity of the development of the cicatricial tissue, which springs up with great luxuriance. They are specially apt to follow the irregular cicatrisation of burns, more particularly in children. I have, however, seen them in the adult, occasioned both in this way and by the irritation of a blister. The warty cicatricial tissue chiefly develops on the chest and neck, and is commonly attended by much itching and tingling, often of a most distressing character. It is very vascular, bleeding freely when incised.

Treatment.—These various forms of tumor should, if possible, be extirpated early by the knife, as they do not appear to be amenable to any constitutional or local treatment, and have certainly a disposition to malignant degeneration. As there is a great tendency to local recurrence of the disease after removal, it should be widely excised; but even then it is likely enough to return, requiring perhaps repeated operations before the patient can be freed from it.

LUPUS.—Under the term *lupus*, various simple specific semi-malignant and malignant affections of the skin, of very different kinds, are commonly included; indeed, the distinctions between lupus and the different forms of epithelial cancer have not as yet been well made out; and the term "lupus" is rather loosely applied to all rapidly destructive forms of chronic ulceration, more especially when affecting the skin of the face. There are three forms, at least, in which the diseases included under the term lupus may make their appearance: 1, as a superficial affection of the skin, not attended by ulceration, but accompanied by important special and destructive changes in its tissue: this is the Lupus Non-exedens of some writers; 2, as the Lupus Exedens, a disease of a rapidly destructive character, not only eroding superficially, but destroying the tissues deeply; 3, as a slowly ulcerating form of the disease, giving rise to the different varieties of Lupoid or Rodent Ulcer. These various forms of lupus are most commonly seated on the face or neck, but are occasionally met with on other parts of the body, as upon the limbs or trunk.

1. **Lupus Non-exedens** appears in the shape of a red patch on the skin, covered by fine branny epidermic desquamation; it may remain stationary for years, or slowly spread over a great extent of surface, producing contraction of the skin, with wrinkling and drawing in of the features, and much stiffness in their movements. The integument affected by it may be in one of two states; it may either continue red, irritable, and branny, having the appearance of a thin cicatricial tissue, and in this way the greater part or the whole of the face may be affected; or it may leave a firm, white, smooth, and depressed cicatrix, exactly resembling that produced by a burn, along the anterior margin of which the disease slowly spreads, in the form of an elevated ridge composed of soft bluish-white or reddish tubercles.

2. **Lupus Exedens**, or the more deeply ulcerating form of the disease, may begin in two ways, with or without the existence of a tubercle on the skin. It is most commonly seated on the nose, beginning by ulceration of the mucous or muco-cutaneous surface, without any precursory tubercle as in the lupoid ulcer, surrounded by redness of a violet or dusky hue, and attended by much inflammation, swelling, pain, and coryza. The ulcer is at first covered by a thick scab; as this separates, the sore extends, and often rapidly destroys one or both alæ, the tip, and columna; after this, the destructive action usually ceases for a time, the sore crusting over with greyish, hard, and adherent scabs; but, if not, it may go on eroding one half the face, producing a frightful rugged-looking cavity, and exposing and destroying the bones and large cavities of the face. I believe, however, that of these forms of disease, that which is limited to the nose, and that which extends widely over and through the face, essentially differ from one another. The first is generally of a *Scrofulous* character, in fact consisting of strumous ulceration in one of the extreme parts of the body, the vitality of which is below its normal standard, and usually occurring in young persons, especially in women from eighteen to twenty-five years of age. A second variety is of *Syphilitic* origin, being one of the most serious forms of remote tertiary syphilis; and the third is the true Lupoid or rodent ulcer.

The *strumous* form of lupus exedens, that which destroys merely the extremity of the nose, is commonly rapid in its progress, the part appearing to melt down under the disease, so that in the course of a few weeks the whole of the organ is destroyed. In other cases it is very slow, occupying perhaps many years, and partaking somewhat of the red and

branny form of lupus non-exedens. Occasionally it is evidently associated with and dependent upon the syphilitic taint, and ought then to be considered rather as a variety of local syphilis in a strumous constitution than as a distinct affection.

Microscopic Structure.—It is not often that we have an opportunity of examining microscopically the structure of the less active forms of lupus. Some time ago, however, I removed by excision a patch of lupus non-exedens, which had existed for fourteen years under the chin of a woman aged thirty, who was otherwise in good health. On examination, it was found to be composed of large cells many times larger than blood-discs, having clear and very distinct cell-walls, and well-marked refracting nuclei. There were some cells clear and globular, without nuclei; others were fusiform and elongated, with nuclei, evidently undergoing fibro-plastic transformation (Fig. 324). Molecular movement was very distinct in one of these globular cells. The mass of skin appeared to be converted into granular matter, intermixed with these cells.

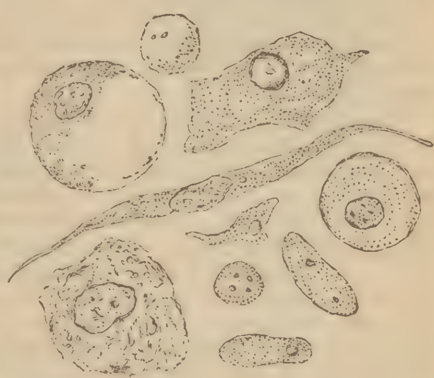


Fig. 324.—Cells from Lupus non-exedens of the Neck.

The **Diagnosis** of scrofulous lupus is not always easy, the disease being specially apt to be confounded with some forms of impetigo, with syphilitic tubercles and sores, and with cancer. From *impetigo* it may be distinguished by the absence of pustules, and of the thick gummy crusts characteristic of this affection, as well as by the less extent of surface implicated, and the deeper and more eroding form of the lupoid ulceration. From *syphilitic disease of the skin* the diagnosis is not always practicable, inasmuch as true lupus may occur as the result of constitutional syphilis. In other cases, the history of the affection, the limitation of the disease, and the absence of intervening secondary manifestations, make it easy to distinguish one from the other. From *epithelial cancer*, lupus cannot in some cases be distinguished; the two affections indeed being closely blended together, and being scarcely recognisable as distinct diseases.

The **Treatment** of lupus depends in a great measure upon the variety of the disease with which we have to do, and the constitutional condition attending it, and calls for the employment not only of local but of general remedies.

In *Lupus Non-exedens* we may, if the disease be limited, excise the patch and heal the sore that results by granulation. Not unfrequently, however, the cicatrix is apt to undergo fibro-vascular degeneration. If recourse be not had to excision, on account of the extent and superficial character of the disease, it is useless to attempt to destroy it by caustics. In every case in which I have seen these tried, they have failed in effecting a cure. In some instances, however, the application of a strong solution of the nitrate of silver to the morbid surface will induce a healthier action; though in the majority of instances local applications

of a soothing kind can alone be borne. Lotions containing glycerine are especially useful, as they prevent the surface from becoming dry and harsh. If the disease be situated on the face, care should be taken to avoid exposure to cold winds, dust, etc. In the *constitutional treatment*, the avoidance of stimulants of all kinds, the use of a bland diet, and the employment of some of the preparations of arsenic, will be found to be the most likely means to effect a cure. Indeed, arsenic may be considered the great remedy in this disease; the liquor arsenicalis, or the iodide in combination with small doses of biniodide of mercury, will be found extremely useful; Donovan's solution is also most beneficial in many instances.

The treatment of *Lupus Exedens* must have reference to the *constitutional* condition in which it occurs; if this be of a strumous character, the administration of cod-liver oil and the iodide of potassium, with a nourishing diet, will be most serviceable; in a syphilitic constitution, the remedies that are applicable to the cure of tertiary syphilis, such as the perchloride of mercury and Donovan's solution, are especially useful. In many cases also in which there can be no suspicion of a syphilitic taint, these preparations of mercury, as well as the iodides of the same metal, may be administered empirically with great advantage. The liquor arsenicalis, or the combination of arsenic, iodine, and mercury that exists in Donovan's solution, or that is contained in a pill composed of one-sixth of a grain of iodide of arsenic and one-twelfth of a grain of biniodide of mercury, as recommended by A. T. Thomson, has appeared to me to be extremely beneficial, and in many cases certainly exercises a marked influence in arresting the disease. Whilst the patient is undergoing a course of these remedies, much attention requires to be paid to his diet, clothing, and general hygienic conditions.

In the *local treatment*, the first thing that requires to be done is to subdue inflammatory action and irritation, by leeches, emollient lotions, and opiate or henbane poultices. As this subsides, the progress of the disease will usually be arrested for a time at least; and then, by the application of the nitric acid, chloride of zinc, or the acid nitrate of mercury, to the surface, a more healthy action may be set up, and the sore be made to cicatrise. Great mischief, however, may result if the caustics be applied too early, or if irritating ointments be used, as the destructive nature of the disease will then be augmented. The inflammatory redness and branny desquamation, resembling lupus non-exedens, that surround the ulcer, may usually most readily be made to disappear by the repeated applications of a strong solution of the nitrate of silver, which should be applied every second day by means of a camel-hair brush. The cicatrix that forms in this disease is thin, and breaks readily, giving way on exposure to cold, or on the occurrence of constitutional derangement. The patient should, therefore, for some length of time after recovery, be careful not to expose himself to any such influences. In the more rapidly spreading and worst forms of lupus exedens, that horrible disease termed by the older Surgeons "Noli-me-tangere," nothing can be done beyond the relief that is afforded by the administration of opiates, and of a general sedative plan of treatment.

3. **Rodent Ulcer** is one of those remarkable affections that stand midway between simple and malignant diseases; being, so far as constitutional causes or secondary complications are concerned, apparently of a simple nature, while, to a certain extent, in regard to structural condition and entirely in respect to local effects, it is of a malignant

character. The disease is especially characterised by its slow progress, by its eroding nature, and by the impossibility of healing it by all ordinary methods of treatment. It is essentially a disease of advanced age, seldom beginning before 45 or 50. Its duration is in any given case indefinite; seldom less than five or six years, occasionally extending to twenty or thirty. It affects individuals of either sex indiscriminately; and usually occurs in persons who are otherwise perfectly healthy. The health also is not influenced materially, if at all, by its long duration. I have seen persons, who have been victims to it for more than twenty years, in apparently robust health. But it is eventually and inevitably fatal, unless removed by operation.

Fig. 325.—Rodent Ulcer of back of hand. Amputation.

It may affect any part of the head, face, or extremities. The face is its seat of election, especially in the upper parts, such as the forehead, the side of the nose, the inner angle of the eye, or the temple. It spreads simply by continuity of tissue, never by disseminated local or by secondary deposits. It may invade all tissues; the skin primarily, the pinna of the ear, the alæ and septum of the nose, the parotid gland, the conjunctiva and the eyeball. It is especially destructive to bone when once it attacks it, and will spread deeply into the cancellous structure, as of the head of the tibia or the diploë of the skull. It erodes and eats away the bone, without caries or necrosis. It may penetrate to the dura mater, and invade the brain. It progresses, however, by preference superficially, not in depth; hence it is seldom attended by hæmorrhage, even in the more advanced stages. The neighboring lymphatic glands do not become implicated, and secondary visceral deposits are never met with. As the ulceration extends, there is often a tendency to imperfect cicatrisation on one margin, whilst the disease is making progress at the other. It always commences in the skin, usually on healthy integument; but occasionally it primarily affects a portion of the skin which is the seat of some chronic change of structure, as a mole, a wart, or a scar.

Symptoms.—In whatever situation it begins, its first appearance is in the shape of a tubercle or hard pimple of a brownish-red color. This is most commonly seen on the side of the nose, on the mouth, or on the cheek. This tubercle ulcerates slowly; and then the disease extends. Moore, to whom we are indebted for a most lucid account of this terrible affection, lays especial stress on its commencement in a hard wart, and its continued extension by a hard margin. This ulcerated tubercle becomes covered by a scab; but, as the process of destructive ulceration progresses, the sore becomes too large to be covered by a scab, and an ulcer is left. The ulcer, which constitutes the disease, and is the true "*Lupus*," or "*Noli-me-tangere*" of the older authors, presents the following characters. It is depressed slightly below the surface, is of a pale pink color, with a furrowed rather than a granulating surface, resembling by its furrowed smoothness an irregular layer of pink wax, and is usually painless,

except where cicatrising. The ulceration, sometimes running on too rapidly for the margin, invades and destroys it in parts, cicatrising unequally and unhealthily; in other cases it leaves in its advance a track of bluish-reddish-white thin cicatrix, which is apt to be again invaded and destroyed by fresh deposit of the lupoid tubercle. In fact, in its ulcerative progress and eroding action, it destroys its own indurated margin, eats away its own morbid deposit more rapidly than it can be reformed, and so, here and there reaching healthy tissues, allows an opportunity for cicatrisation to take place on one side, whilst it is progressing on another. The cicatrices are altogether unstable, and are liable to be broken down by these renewed invasions of the disease. Whether it be fast or slow, the course of the disease is always progressive; more rapid in the skin, more slow in the bones and less vascular tissues, as those of a cartilaginous and fibroid character; the pinna of the ear, the sclerotic, and the septum of the nose, for instance. When it attacks bones, it perforates them, and sinks deeply into their softer parts. Moore has noticed that the morbid growth in front of the advancing disease is always most clearly marked in cancellated bone—in the diploë, for instance. The soft parts immediately contiguous to the disease are perfectly healthy and uninfiltrated; and there is never, even after many years of progress, any sign of secondary affection of the lymphatic glands. Unless the progress of this ulcer be arrested by treatment, it is never interrupted, but will terminate in the death of the patient. This fatal termination may, however, be long delayed. The accompanying Fig. 326 is from a patient of mine who had suffered from the disease for nearly thirty years, but who was to all appearance in perfect health, although the skull was perforated, the dura mater exposed, and the pulsation of the brain distinctly visible.

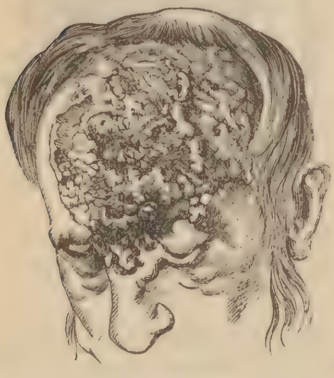


Fig. 326.—Rodent Ulcer; Perforation of Skull and exposure of Dura Mater.

Diagnosis.—The diagnosis has to be made from Epithelioma, Syphilis, and Lupus. The distinction from ordinary *epithelioma* is often at first difficult; but in the later stages the absence of glandular affection, the small amount of growth compared to the ulceration, and the prolonged course of the case, render the diagnosis easy. From *tertiary syphilis* it is clearly distinguished by the duration of the case. In syphilitic ulceration "the rate of destruction is measured by weeks; in rodent cancer, by years." There is also an absence of all other signs of constitutional syphilis. From ordinary *lupus* it is distinguished by the age and healthy constitutional state of the patient, by the singleness of the ulcer, and the absence of the pink, scaly, or œdematous skin frequently found around lupus. Lupus may cicatrise and cease at any time; rodent cancer never does. Lupus possesses contractility; rodent cancer has none. Lupus rarely causes death; rodent ulcer is always eventually fatal.

Pathology.—The microscopic characters of the solid infiltrating substance have been examined by Moore, Hulke, and C. Warren, all of whom have found some parts which presented appearances identical with epithelioma. Moore found this in the diploë of the frontal bone, and Hulke

in a part of the globe of the eye implicated in the disease. The greater part of the growth presents characters differing but little from those of ordinary granulation-tissue. Moore was of the opinion that the growth commenced in all cases in a pimple identical in structure with epithelioma, but that this character was lost as the growth extended, but could be readily assumed again in "certain situations or in convenient textures."

The conclusions at which Dr. Collins Warren arrives as the result of his researches, are, that rodent ulcer is a form of epithelial cancer; and that it differs from the more ordinary forms of epithelioma in the small size of the cells. The arrangement of these epithelial cells may be tubular and alveolar (Fig. 327).

Fig. 327.—Vertical Section of Rodent Ulcer—*a*, Epidermis balls—*b*, Stroma (after C. Warren).

We have seen from the foregoing description of the disease, that rodent cancer is a solid growth, having no limitation by a cyst, infiltrating and superseding the natural textures, exhibiting a power of continuous increase, infecting the adjoining parts, so that an incision, where they appear healthy, is yet followed by a return of the disease, and ultimately degenerating and disappearing, destroying with itself all the tissues which it had penetrated. On these grounds Moore considers himself justified in classing it with the cancers, in spite of the absence of glandular and constitutional infection.

But this view appears to be open to doubt. Although it is impossible not to admit that in some cases, and in some parts of most cases, rodent ulcer is in its histology closely allied to, if not identical with, some of the less active forms of epithelioma, yet it is equally certain that the great mass of the active part of a rodent ulcer presents nothing that is structurally cancerous, and that clinically it differs from all and every variety of that disease in the most marked manner. We have abundant proof in other diseases, such as the enchondromata, for instance, that they may differ from cancer histologically, but resemble it clinically in some of their varieties. May we not with justice see the converse here: viz., a disease that somewhat resembles histologically, but that differs in every respect clinically from, a cancerous deposit? Clinical affinity is surely of as much account as histological resemblance.

Let us compare the two affections in their leading characters.

In cancer the disease often commences in early or at most middle

life; the rodent ulcer always in advanced life or old age. In cancer, there is an active vegetative outgrowth; in rodent ulcer, destruction and absorption of tissue. Cancer usually commences deeply—rarely in the skin, which is involved secondarily; rodent ulcer always in the skin primarily, never in the deeper parts. Epithelioma ever affects primarily the mucous or muco-cutaneous surfaces; rodent ulcer, always the true skin. Cancer is rapid in its local progress; rodent ulcer is slow beyond any other disease. Cancer is often primarily multiple, especially when superficial, developing or rapidly extending by many scattered tubercles; rodent ulcer is always single, arising from one solitary starting point. Cancer speedily gives rise to secondary deposits in contiguous structures; rodent ulcer, never. Cancer leads to secondary visceral deposits; rodent ulcer never leads to implication of internal organs. Cancer produces constitutional cachexy, blood changes, and malnutrition; rodent ulcer, even when most chronic, is usually associated with perfect health. A cancerous ulcer shows no tendency to cicatrise; a rodent ulcer always gives evidences of imperfect attempts at repair. A cancer, when removed by operation, almost invariably recurs; a rodent ulcer, if completely extirpated, has no tendency to recurrence.

Thus, then, in all essential respects, except in the one of occasional similarity in structure, so far as the hardened edge of the rodent ulcer is concerned, the two diseases are not only so dissimilar, but even so clinically opposed, that it does not appear to be justifiable to group them together. It may, in fact, be said that rodent ulcer is allied to, but not analogous to, the cancers; that it is more local and less constitutional, even secondarily, than epithelioma; that, although allied to and in parts presenting some of the characteristics of this disease, yet it approaches much more nearly the ordinary structure of granulation-tissue; that in point of malignancy, indeed, it stands in the same relation to epithelioma that this latter form of cancer does to the more active variety of scirrhus; that there is just enough of malignancy in it to prevent the attempts of cicatrisation from becoming effectual, but not enough to occasion rapid progress in local ulceration, or to give rise to constitutional infection. From scirrhus to epithelioma, from epithelioma to rodent ulcer, we thus find, with certain intermediate links of structural affinity, a progressive decadence in the force of malignant action.

Treatment.—In the treatment, constitutional remedies are of no use, and local means alone are to be relied on. They consist: 1, in the application of caustics; 2, in excision of the part; 3, in a combination of these two methods.

1. The ulcer may best be destroyed by the application of the chloride of zinc paste to the whole of its surface. The best mode of applying this is to keep the chloride prepared for use by being mixed with two or three parts of flour. When wanted, a sufficient quantity of this powder should be made into a stiff paste, by the addition of a little water, and then spread over the surface to be attacked by it, in a layer of about the thickness of a wafer; this should be left on for two or three hours, and then removed, the sore being covered with a piece of water-dressing until the greyish slough that has been produced has separated, when the caustic may be reapplied as often as necessary. Besides the chloride of zinc, various other caustics may be had recourse to, each of which possesses some peculiar advantages. The nitric acid is useful, if the action to be produced be not required to be very deep; for, as it hardens and coagulates the tissues to which it is applied, it does not consequently extend so far as the chloride. The acid nitrate of mercury presents the

same advantage as the nitric acid and other fluid caustics—that it can be applied into the fissures and hollows of the part into which the more solid caustics do not penetrate, and is certainly useful in inducing a healthy action in the part, especially if there be a syphilitic taint. The potassa fusa and Vienna paste are useful, so far as their destructive properties are concerned, but are somewhat uncontrollable, and apt to spread. The most convenient mode of applying them is to cut in a piece of plaster a hole of the exact size and shape of the ulcer, to apply this around its borders, then to cover the sore with a layer of potassa cum calce, one line in thickness, and over this to lay on another piece of plaster. In this way a considerable amount of caustic action may be induced, which will be limited to the exact surface to which it has been applied. Of all these escharotics, the preference is to be given to the chloride of zinc; its action is more continuous and more controllable, and it appears to give a healthy stimulus to the subjacent structures.

2. Excision of the whole of the ulcer may sometimes be very advantageously practised, especially when it is situated on the cheek, eyelid, eye, or forehead; and the gap left may be filled in by some of those plastic processes that will be described when we come to speak of the Plastic Surgery of the Face.

3. When the ulcer has attained a large size, when it is complicated in its outline, and irregular in its depth, the question arises whether surgery offers any resource, or whether the patient should be left slowly and miserably to die.

In these extreme cases even, something may be done to prolong life and to relieve suffering, even if no cure be ultimately to be expected. Moore proved that, unless the brain be implicated, or some large vessel involved, something can usually be done at least to arrest the rapidity of the growth. The method which he adopted was a combined use of the knife and of chloride of zinc. By these means he removed in some cases the whole of the affected parts, leaving a huge chasm in the face, and even in one case exposing the dura mater for a considerable extent over the roof of the orbit. The operations were done on no regular plan, the incisions being directed solely by the shape of the growth, and no attempt being made to repair the deformity left. The results of these operations were, on the whole, favorable. Out of six cases three recovered, and the three others received decided benefit, but were not permanently cured. In all the cases in which chloride of zinc came into actual contact with the dura mater, epileptiform fits occurred, but only of a temporary character.

When the disease is situated in an extremity, and the cancellous end of a bone especially is involved, as when it dips into and erodes the head of the tibia or the lower end of the radius, amputation would be the proper and only advantageous procedure.

When the disease is so extensive, or so situated, that absolutely nothing in an operative way can be done, the Surgeon must content himself by covering up the raw surface with lint soaked in glycerine and water, and protected by oiled silk.

Cancer of the Skin.—Cancer may occur in the skin as a true scirrhous deposit. Most commonly, however, those affections of the skin termed cancerous consist of the epithelial form of the disease, and are usually seated about the lips, face, and scrotum, or at the orifices of the mucous canals; these we have already considered generally, and shall have to revert to them more fully when treating of the special affections of these parts.

True cancer of the skin may occur in three forms: 1, as the Indurated Wart of a scirrhous character, specially described by Scarpa; 2, as Scirrhous Infiltration and Fungus; or 3, as Ulcers which, primarily originating from local irritation of a simple kind, may, by the persistence of this, assume a truly cancerous character; thus I have seen the scrotum and the neighborhood of the apertures of fistulæ in perinæo, in a case of old-standing disease, become converted into a truly scirrhous mass.

Cancer of the skin is apt to assume a *melanotic* character, owing to the large development in it of black pigmentary matter. Closely allied to it in appearance, if not in histological structure, is that most malignant disease (see p. 752) **Melanotic Sarcoma,** which may be developed in connection with the integumentary structures. I have met with two instances of late of this disease, one on the foot, the other on the hand, of ladies both above seventy years of age. The disease may readily be removed by caustics or the knife. Some time after removal in both cases, brownish black patches looking like stains with Indian ink appeared on the skin in the neighborhood of the cicatrix. These gradually developed into new deposits. In one case hundreds of these formed up the leg, varying in size from a pea to a filbert. They slowly ulcerated and destroyed life probably by secondary visceral deposits after a period of about four years from the primary manifestation of the disease.

1. The **Scirrhous Wart** is usually of the natural color of the skin, but sometimes of a reddish or dark-greyish hue, hard, and somewhat irregular in shape It may remain for a long time stationary, but at last ulcerates and spreads rapidly, giving rise to vast destruction of parts; the ulcers formed by it presenting the characters of cancer, with a hard base, everted edges, and foul surface.

2. The **Infiltrated Cancer of the Skin** occurs in the form of a flat, dark, irregularly defined induration which scabs over with dark, rugged, greyish-brown incrustations, having shooting pains in and around it, and, after remaining stationary perhaps for years, runs into ulceration, and rapidly destroying the parts it affects. After ulceration has been set up, the patient's life, according to Walshe, is seldom prolonged beyond two years. *Encephaloid Cancer* of the skin is of rare occurrence, but occasionally forms large fungating masses sprouting from, and solely connected with, this tissue.

3. **Cancerous Ulcers of the Skin** may arise from any local irritation; or an unhealthy and specific action may be set up in an old scar or ulcer, and cause it to assume a cancerous character (Fig. 328). These cancerous ulcers may indeed occur upon almost any part of the body; I have seen them on the back, breast, fingers, hand, thigh, and sole of the foot. They are flat, grey, or sloughy-looking, often with large warty granulations and protuberant masses, a good deal of induration about them, and but little discharge. Their structure is usually that of scirrhus, but not infrequently melanotic growths and masses of melanoma are developed in them, and the neighboring epidermis may be black in patches from melanotic deposits.

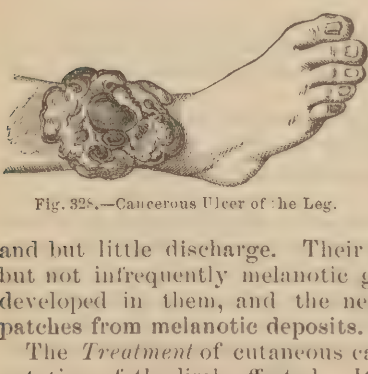


Fig. 328.—Cancerous Ulcer of the Leg.

The *Treatment* of cutaneous cancer consists in its excision, or in amputation of the limb affected. Its removal by excision, whether in the

form of wart, crust, or ulcer, should be effected as soon as its true characters have declared themselves; provided it be of such a size, and so situated that it can be freely removed with a sufficient stratum of subjacent healthy parts, and a wide border of surrounding skin. Should it be so situated that its excision through surrounding healthy tissue is not practicable, the limb must be amputated, as was done in the case depicted in Fig. 328. In such circumstances the limb may be removed at no great distance above the disease; it not being necessary, as in cases of cancer of the extremities where the bones are affected, to allow a joint to intervene between the seat of operation and the malignant growth.

CHAPTER XXXVIII.

DISEASES OF THE NERVOUS SYSTEM.

NEURITIS.

Inflammation of the Nerves, or rather of the neurilemma, is not of very unfrequent occurrence, being usually the result of rheumatism, of wounds, or of strains. When neuritis is rheumatic, it principally affects the nerves of the face and the lower extremity.

Symptoms.—These consist of tenderness on pressure along the course of the nerve, and severe continuous pains running along its trunk and ramifying along its branches, with occasional violent exacerbations, especially on moving or touching the part, and at night; there are usually swelling along the course of the trunk, and some pyrexia. When chronic, this condition may readily be confounded with neuralgia; of which, indeed, it constitutes one variety. On examination after death, the sheath of the nerve will be found injected and swollen, and the nervous tissue softened.

Treatment.—This consists in the employment of antiphlogistic means; cupping or the application of leeches, according to situation, poppy or belladonna fomentations, and local emolients. When the neuritis is rheumatic, the acetous extract of colchicum is the best remedy; when it is more chronic and nocturnal, iodide of potassium, either alone or in combination with sarsaparilla, may advantageously be given.

NEURALGIA.

Neuralgia frequently occurs in surgical practice, either complicating other diseases, or as a distinct affection simulating closely various organic lesions, more especially of joints and bones.

Symptoms.—The pain in neuralgia is the essential symptom, and, in fact constitutes the disease itself. It may be of two kinds; either following anatomically the course of a nerve and the distribution of its filaments; or affecting a considerable portion of the surface without reference to any special nerve. It is of all degrees of severity, sometimes moderate, sometimes unbearable, even by those who possess the greatest fortitude; when severe, it usually comes on suddenly, with a kind of shock, and continues of a sharp, darting, or tearing character, coursing along the trunk or ramifications of the affected nerve, the distribution of which may often be distinctly indicated by the direction the pain takes.

It is often accompanied by other sensations, such as a tickling, smarting, or creeping feeling on the affected surface; in some instances relieved by pressure, in others increased by the slightest touch or movement of the part. Occasionally there is spasm in the muscles supplied by the affected nerve; in other cases, there are heat and redness of the surface, with increased secretion from the neighboring organs, as a flow of saliva or tears when the nerves of the jaw or eye are implicated. The duration of attack may vary from a few moments to many days or months. The pain is most commonly intermittent or remittent; it is often irregularly so, but in some instances the periodicity is well marked.

Situations.—This disease may affect almost any part of the body; it is most commonly seated distinctly in the trunk and branches of a nerve. The divisions of the fifth pair are the most frequent seat of neuralgia; the pain may extend to the whole of the branches of this nerve on one side of the head and face, but more commonly it is confined to one of its principal divisions, such as the infraorbital, which is especially liable to be affected; in many instances it is seated in the temporal and dental nerves. Not unfrequently some of the terminal twigs alone of one of these nerves become the seat of intense pain; thus occasionally the affection is found limited to a patch on the cheek, brow, or temple, from which it scarcely ever shifts. The posterior branches of the dorsal spinal nerves, and the intercostals, are also very commonly affected, though not to the same extent as the fifth pair. In other cases the whole of an organ, or part, becomes the seat of neuralgia, though no one nerve may appear to be distinctly implicated; thus the testes, the breast, the uterine organs, or one of the larger joints, as the hip or knee, are occasionally the seats of severe suffering of this kind. Extreme cutaneous sensibility is a marked feature in some cases; the patient wincing and suffering severely whenever the skin is pinched or touched, however lightly.

Causes.—The causes of this painful disease are very various; they may be constitutional or local. It seldom occurs in strong and healthy individuals, but is almost invariably associated with want of power, unless it be occasioned by some local mechanical cause. *Depressing influences* of all kinds are especially apt to produce it; thus, debilitating diseases, mental depression, and particularly exposure to malaria, are common occasioning causes; those forms of the disease that arise from malarial influences, or from exposure to simple cold and wet, usually assume a very intermitting or periodical character, and are commonly seated in the nerves of the head. The *hysterical temperament* very frequently disposes to the spinal and articular forms of neuralgia. There is no constitutional condition with which neuralgia is more frequently associated than with anæmia: hence its frequency in females. As Romberg somewhat poetically says, "Neuralgia is the prayer of the nerve for healthy blood." Various sources of *peripheral irritation*, as loaded bowels, the irritation of worms, carious teeth, uterine disease, and calculus, may be recognized as producing some of the more obscure varieties of the disease.

Neuralgia may also arise from any compression exercised upon the trunk of a nerve; and in this way, indeed, some of the more intractable forms of the affection have their origin. Thus, thickening of the neurilemma, the presence of a tumor of any kind, or of a piece of dead bone, may give rise to the most intense pain in the part supplied by the irritated nerve; and it is not improbable that, in many of the cases of neuralgia in the branches of the fifth nerve, pain may be owing to peri-

osteal inflammation, or to some other disease of the osseous canals through which the divisions of the nerve pass.

Diagnosis.—The diagnosis of neuralgia, though usually affected without any difficulty, is in some cases a little embarrassing, as the pain may occasionally simulate that of organic disease or inflammation of the part. From *organic disease* of the part that is the seat of suffering, such as the hip, the knee, the testis, or the breast, this disease may usually be distinguished by the co-existence of cutaneous sensibility, the existence of the hysterical temperament, and the absence of the other signs that would accompany lesion of structure in the part affected. From *inflammation* the diagnosis is usually sufficiently easy, by attending to the intermittent character of the neuralgic pain, to its occurrence in hysterical temperaments, and to the absence of the constitutional symptoms of inflammation. But occasionally, when local inflammatory irritation is conjoined with the neuralgia, the diagnosis is difficult. Here the presence of cutaneous sensibility and the relief of the pain by firm pressure will indicate neuralgia; whereas, in inflammation, there is no tenderness of surface, but the suffering is aggravated by deep pressure.

Treatment.—The treatment of neuralgia must have reference to the cause of the disease, and will be successful or not according as this may be more or less readily removed. So long as the conditions that primarily occasion the disease subsist, the pain is likely to continue: and if these conditions be irremovable, the disease may be looked upon as necessarily incurable, though the suffering may be alleviated by appropriate means. When it arises from any central nervous affection, there may be fear of the ultimate occurrence of disease of a more serious type, such as epilepsy, insanity, &c.

When it occurs as the consequence of anæmia, or in the hysterical temperament, the administration of the more stimulating and stronger preparations of iron, such as the sulphate or the perchloride, or the mistura ferri composita, either alone or in combination with quinine, with attention to the state of the bowels and of the uterine functions, and a general tonic regimen calculated to brace and improve the general health, such as sea-bathing, the cold douche, or sponging, will be of essential service. In some of these cases the combinations of zinc, especially the valerianate, with the fetid gums, will remove the disease when iron does not influence it much. At the same time, the application of belladonna or aconite plasters, or the inunction of these liniments may be of service. When the neuralgia is distinctly periodical, quinine in full doses, or the liquor arsenicalis, will usually effect a speedy cure. When it is rheumatic, occurring in debilitated subjects, and attended by distinct nocturnal exacerbations of pain, no remedy exercises so great an impression upon it as the iodide of potassium, especially when administered in combination with quinine.

In the more severe and protracted forms of the disease, relief may be occasionally obtained by attention to the state of the liver and digestive organs, by a course of some of the more purgative mineral waters, and by the occasional administration of aloetics or croton-oil, followed by tonic remedies.

Local applications of a sedative kind, such as chloroform, belladonna, aconite, opium, &c., are often useful adjuncts to constitutional treatment. By far the readiest mode of affording relief locally is the hypodermic injection. Not more than from one-sixth to a quarter of a grain of morphia should at first be used at one time, and the action of this small dose is often very powerful. More than this, it is unsafe to begin

with; but the quantity may be enormously increased. I have had a patient who, to relieve the pains attending cancer of the rectum and anus, required no less than six grains to be injected every twelfth hour. In some cases a single injection has cured neuralgia which has resisted all other means.

In many cases all these means, however, are unfortunately unavailing, and the sufferer is doomed to an existence of almost constant pain, except at times when the disease appears to cease of itself, or has its intensity blunted by the administration of the more powerful sedatives, such as morphia hypodermically, or veratria, aconite, or atropine externally. In these distressing cases the sufferer is ready to grasp at any means of relief that is held out to him; and section of the affected nerve is not unfrequently recommended as a last chance of the removal of the disease. It is clear, however, that such an operation, though occasionally productive of temporary relief, cannot in most cases be expected to benefit the patient permanently; for by it the cause of the neuralgia is not removed, and it can consequently only be of service when the pain is peripheral, occasioned by some local irritation existing between the part cut and the terminal branches of the nerve. If the neuralgia depend on any central cause, or on local irritation existing higher up than the point divided, the operation must eventually be useless. Thus, if the source of irritation exist in the terminal branches of the infraorbital nerve, the division of this trunk might be useful; but if the pain be occasioned by any pressure to which this nerve may be subjected in its passage through its canal by a carious state of the bones, or by disease of the periosteum, it would be unavailing; though it is a remarkable fact, that it not unfrequently happens that there is after these operations a temporary cessation in the pain for a few weeks or months. In some of these cases, however, the pain shifts its seat from the branch operated on to another division of the same trunk; thus, if the infraorbital have been divided, the inferior dental or submental nerve becomes the seat of pain. Or this may ascend, as it were, to the point at which the nerve was divided; thus, after amputation for neuralgia of the knee, the pain may return in the stump, and again when this is removed a second or even a third time.

The nerves on which section has been most frequently performed are the different branches of the fifth—the infraorbital, the inferior dental, and the submental. Should it ever be thought necessary to do it, it would be proper not only to divide the nerve, but to excise a portion of it; otherwise reunion will speedily take place, and the continuity of the nerve being re-established, the operation will fail. The procedure, when applied to the infraorbital and the submental nerves, simply consists in cutting down on the trunk where it escapes from the foramen, isolating and dissecting out a portion of it; in doing this, no great difficulty can be experienced by any one possessing moderate anatomical knowledge. Langenbeck has proposed excision of that part of the infraorbital nerve which lies in the orbit. A tenotomy-knife is carried along the outer wall of the orbit, and the nerve is divided where it escapes from the spheno-maxillary fissure. Wood of New York has successfully excised the trunk as far back as its exit from the skull through the foramen rotundum. In one case of his which I have seen, a complete cure was effected, the patient, a healthy man, being entirely free from the neuralgia one year and a half after the operation.

Facial Neuralgia more frequently takes its origin in the irritation of a dental nerve than in any other branches of the fifth. This neces-

sarily arises from the frequency with which the terminal branches of these nerves become irritated in consequence of the presence of carious, broken, inflamed, or over-crowded teeth; and on the removal of these local and eccentric causes of irritation the pain usually ceases. There is, however, one form of neuralgia of the dental nerve that is so severe and so persistent in its general duration, and so paroxysmal in its attacks, that it constitutes a true *Tic*. This neuralgia may affect either jaw. I have most frequently met with it in the lower, and more commonly in women than in men. It occurs in people who have lost teeth; and the pain, which is excessively acute and paroxysmal, commences in and darts from the contracted alveoli and the condensed and indurated gum covering them. It appears to be owing to the compression of the terminal branches of the dental nerves by the contraction upon them of the empty alveoli. Taking this view of the pathology of this form of neuralgia, I have treated it by the removal of a portion of the indurated alveolar border and gum. Some years ago I did this in a patient of Dunn's, removing a V-shaped piece of the bone by means of a Hey's saw; and more recently, I have in addition clipped away the bone by means of cutting pliers. Gross, who has directed attention to this form of neuralgia, uses the pliers only for the removal of the affected bone. In any case it is necessary to cut into, but not through, the body of the bone. By this incision, the dental canal may be opened in the body of the bone, and the nerve destroyed by means of the galvanic cautery. The inferior dental nerve has in some cases of intense and persistent neuralgia been divided by a very ingenious operation. This consists in dissecting up a flap over the ramus of the lower jaw, applying a trephine to the bone so exposed, and cutting out a portion of it over that part where the nerve enters the dental canal, which is thus laid bare; when a portion of the nerve may be excised, by being raised on a director, and snipped away with scissors.[1]

Traumatic Neuralgia is commonly the result of gun-shot injury, of the implication of nerves in cicatrices, or of their compression by callus. The neuralgia in these cases is usually of the most intense character, often attended by spasm of the muscles, and sometimes by anæsthesia of parts of the limb affected. It is due to the extension of inflammation of and chronic thickening of the membrane, and the interfascicular areolar tissue, which becomes immensely hypertrophied, thus compressing the nerve fibres. The accompanying drawing (Fig. 529), from a case in which Drs. Sands and Seguin, of New York, excised the cords which go to form the brachial plexus, close to the intervertebral foramina, illustrates well this compression of the nervous structure by dense masses of interfascicular areolar tissue greatly hypertrophied, and permeated by dilated blood-vessels.

Treatment.—The smaller nerves of the limbs have repeatedly been divided or partially excised, in cases of persistent traumatic neuralgia. The larger nervous trunks, such as the median, musculo-spiral, and ulnar, have been treated in the same way in the upper; and the external popliteal, and even the sciatic nerve in the lower limb, has been partially excised as a last resort in extreme cases. These operations have in some cases effected a permanent cure, in others they have been followed by temporary relief only.

It was reserved for Sands, of New York, to remove a section of the

[1] See Dr. Weir Mitchell's admirable monograph on "Injuries of Nerves and their Consequences."

whole brachial plexus close to the exit of the nerves from the spinal column. This was done in a lad aged eighteen, whose right arm had been seriously injured in firing a salute. The arm was amputated, but the patient suffered the most agonizing torture from chronic nerve-lesion high up in the limb. So great were his sufferings that he became uncontrollable in his actions, and, though perfectly sane, gave way to fits of the most intense excitement.

Fig. 329.—Section from Lower Cord of Brachial Plexus near Intervertebral Foramina, showing the lesions of Chronic Neuritis.

a. Secondary fasciculi, showing atrophied fibres (circles not much larger, under 300 diam., than those of normal nerve under 65 diam.); very few axis cylinders present. Tissue between fibres increased.

a′. Small aggregation of fibres, separated from others by dense inter-fibrillar connective tissue.

b. Immensely hypertrophied inter-fascicular areolar tissue Sheaths of fasciculi no longer distinct.

c. Dilated blood-vessels surrounded by altered connective tissue.

d. Yellow granular pigment lying in areolar tissue, mostly in neighborhood of vessels (Sands and Seguin).

The operation consisted in making an incision along the outer border of the right sterno-mastoid, and a transverse one following the line of the clavicle. The ⌋-shaped flap was turned up, the carotid sheath and its contents carried to one side, and the brachial plexus exposed. A piece fully a quarter of an inch in length was cut out from the four lower cervical and first dorsal nerves, from which Fig. 329 has been taken. Considerable improvement, though not complete relief from suffering, followed the operation.

Stretching of Nerves.—Nussbaum has the great merit of having introduced this operation for the cure of traumatic neuralgia. In a case of this kind affecting the arm, and resulting from gun-shot injury, he cut down on and stretched the ulnar nerve, then the nerves surrounding the brachial artery, and lastly the brachial plexus itself, pulling vigorously on the nervous cords. The result was a perfect cure. This operation has been done successfully by Callender on the median nerve, by Marcus Beck on the cords of the brachial plexus in a case of intense neuralgia

and spasm of the stump after amputation at the shoulder, and by others. The effect of the stretching is doubtless to break through the hypertrophied and condensed neurilemma and interfascicular areolar tissue, and thus to relieve the nerve-trunks of undue pressure.

NEUROMA.

By **Neuroma** is meant a tumor connected with a nerve (see also p. 738). This tumor may vary from the size of a millet-seed to that of a melon; it is usually solid and composed of fibrous tissue; but when it attains a large bulk, a cavity may form in it, containing a yellowish or brownish serous-looking fluid, apparently owing to the disintegration of the central portions of the mass. In shape it is usually oval or oblong, the long axis corresponding to the course of the nerve (Fig. 330); it grows slowly, and is movable transversely, but not in the direction of the nervous trunk on which it is seated; it has no appearance of malignancy, and, however large it becomes, it never contracts adhesion to the integument nor involves its structure. Neuroma commonly only affects the nerves of the cerebro-spinal system; but Bérard has met with one case of the disease on a ganglionic nerve. The nerves of special sense are but very rarely the seat of this disease. Indeed, the only recorded case with which I am acquainted of a neuroma connected with one of these nerves, is one described by Lidell of New York, of a neuroma of the optic nerve filling up the orbit, flattening and protruding the eye, and extirpated together with the contents of the orbit by that Surgeon.

Fig. 330. — Neuroma with Nervous Filaments spread out over Tumor.

Most commonly the tumor is single, and then is usually attended with very severe lancinating or neuralgic pain, which extends, however, only to the parts below the tumor, and is commonly paroxysmal. This pain is evidently owing to the stretching of the nervous twigs as they pass along the convexity of the growth. When single and painful, the tumor sometimes goes by the name of the **Painful Subcutaneous Tubercle,** though the name is also applied to another form of tumor (see p. 732). It is then usually met with from the size of a pin's head to that of a cherry-stone, commonly seated upon the limbs, and most frequently in connection with one of the nerves of the lower extremity: but it may be situated upon the arm, the trunk, or even on the scrotum and cheek, where, however, it is not so commonly met with. Wherever a single neuroma occurs, it is acutely and intolerably painful on being touched, and is usually tender as well. It is a very remarkable fact that, though neuromatous tumors when single, or when but two or three exist, are most acutely painful, yet, when they are generally diffused over the body, they lose their sensibility, and are unattended by any inconvenience except such as arises from their numbers and bulk. The number of masses thus formed is often amazingly great; thus, in one of R. W. Smith's cases, described in a monograph which contains the fullest and most accurate account of this disease, he counted in the two lower extremities alone more than 250 of these tumors, besides those in other parts of the body. In another case related by him, there were upwards of 200 small

neuromata scattered over the sides of the chest and abdomen, 450 on the right lower extremity, and upwards of 300 on the left; altogether probably not less than 2000 of these growths in "this unprecedented case."

STRUCTURE.—The single neuroma is composed of a white or greyish fibrous mass developed in the neurilemma, and having nervous filaments stretched through or over it. The nervous trunk above and below the tumor is normal; it is only where it comes into contact with the neuroma, and is exposed to its pressure, that it undergoes the change indicated.

Traumatic Neuromata may arise from the wound or partial division of the nerves, and occasion the most intense agony. Sometimes growths of this description of a fusiform shape, and varying from a cherry-stone to a pigeon's egg in size, are met with in stumps after amputations; in many instances they are unattended by inconvenience, but occasionally give rise to very severe pain.

TREATMENT.—The treatment of painful neuromata, whether of an idiopathic or traumatic character, or existing in stumps, consists in their excision. After removal, the part supplied by the nerve, which is usually necessarily divided, becomes paralysed for a time, but may eventually regain its sensibility. In some cases, however, by cautious dissection, the tumor may be removed from the nerve that is in contact with it, without cutting this across. This has been done in the case of neuromata of the sciatic nerve and its divisions. When these tumors are numerous, they should not be interfered with; and, if unattended by pain, they need not be excised unless their bulk prove inconvenient.

TRAUMATIC PARALYSIS.

Traumatic paralysis is referable to four distinct sets of causes. First, it may arise from *Compression of the Brain*, giving rise to hemiplegia or more general paralysis, according as to whether the cause of pressure be confined to one side, or extend to the brain substance generally, so as to injure or influence it more widely. Secondly, it may arise from *Injury of the Spinal Cord*, giving rise primarily or secondarily to lesion of the substance, either by laceration, compression, or ultimate disintegration; paraplegia of the parts below the seat of injury being the result. Thirdly, *Pressure on Nerves* at any part of their course, from their roots to the terminal subdivision of their trunk, may occasion paralysis of the parts supplied by them. Fourthly, *Section of a Nerve* will necessarily destroy all sensation and motion in the part to which it is distributed. From whatever cause it arises, traumatic paralysis may present every possible amount of diminution of nervous power, from the slightest impairment of sensation or of motion in a limb, to complete annihilation of both. But not only does the actual degree of loss of sensory or motive power vary greatly, but the relative degree of impairment of sensation and of motion is equally variable. In the great majority of cases both are tolerably equally affected. But, in not a few instances, the diminution of one far exceeds that of the other. Thus the motor power may to a great extent be lost in a part, whilst sensation appears to be normal. But this is often more apparent than real; for a diminution of motor power, however trifling, is at once perceived; whilst an impairment of sensation, even though considerable, may long escape detection. Hence it is that motion seems to be more frequently lost than sensation, though the latter may be equally impaired. A per-

son who suffers from a slight degree, however trifling it may be, of impairment of motion or of want of harmony between the action of the muscles of a part, may not be conscious of this while at rest, but it manifests itself unmistakably when he brings the part into movement; whilst neither he nor others may be capable of observing the corresponding loss of sensibility unless it be most minutely and accurately tested. But not only may sensation and motion, one or both, be impaired or lost, but the more complete loss of one of these may be associated with an exaltation of the other. Thus there may be loss of motion in a part, with increased or nervous sensibility of it; in these circumstances, instead of being relaxed and soft, as is the case when there is anæsthesia, it is most commonly rigidly contracted, hard, and resistant, a species of neuralgic paralysis being developed. Or the converse condition may exist, and loss of sensation more or less complete may be associated with muscular tremor or spasm.

1. **Paralysis from Compression or Injury of the Brain** (*vide* Chapter XXIV.) may be occasioned by pressure primarily exercised on the surface of the organ, as by a portion of depressed bone, of clotted blood, or foreign body of any kind; or it may arise, secondarily, as the result of inflammatory effusion, of softening and disintegration of the cerebral tissue, and consequent effusion of blood into its interior. It need scarcely be said that, the more a compressing cause is localised to one hemisphere, the more likelihood will there be of the paralytic symptoms assuming the hemiplegic character, affecting the side opposite to that injured. The more general the compression, and the more it implicates the base of the brain, the greater the probability of the paralysis being more or less general. So these forms of paralysis, when secondary or remote, depending on lesion of the brain-substance, of a disintegrating character, are often mixed up with many symptoms that point to the co-existence of chronic forms of meningeal inflammation, and also a series of complex phenomena that are not very easily unravelled.

2. Those forms of **Paralysis that arise from Injury of the Spinal Cord** may either be primary, depending on its compression or section, or more or less complete destruction, as in fractures or dislocation of the spine, or its complete compression by intraspinal meningeal hæmorrhage; or they may be secondary and due to more or less rapid and complete softening and disintegration of the cord, as the result of impairment of the nutrition dependent on changes due to inflammatory mischief extending to it from its membranes, originating in it as the direct consequence of injury. In all these cases, the paralysis partakes of the paraplegic character. The degree to which it extends will necessarily depend on the more or less complete involvement of the cord by the injury, or the depth of its disintegration by disease. There may only be a very slight impairment or loss of harmony of motor power in the limbs, or there may be any increase of this impairment up to complete loss of all motion and sensation in them. In many cases the sphincters of the bladder and anus are unaffected, or they may completely lose all controlling power. These forms of paralysis often affect the two lower limbs very unequally, both as to the extent of the loss of sensation and motion, and as to the impairment of one power rather than the other in one or other of the extremities. The symptoms vary from a simple drag of the foot, with no appreciable loss of sensation, to complete inability to walk or even to stand, and to absolute insensibility to the application of the most powerful galvanic stimulant. These forms of spinal paralysis, when arising primarily from injury to the vertebral column, more

particularly from its fracture, are often associated with intense neuralgic pains, which dart along the line of junction between the sound and paralytic parts; when they arise from secondary inflammatory affections of the cord, they may be attended by the various symptoms indicative of myelitis, whether in the acute or the subacute form, such as spasmodic drawing up of the great toe, cramps in the legs, or neuralgic darting, with abnormal modifications of sensation through the limb.

3. **Pressure on a Nerve** at some part of its course, between its origin and the termination of its main branches, is a frequent cause of local traumatic paralysis, often of a somewhat transitory character. A familiar instance of this is afforded by the loss of power, both sensitive and motor, that is often noted in the hands and arms of people using and leaning heavily on crutches. The same partial paralysis frequently accompanies certain forms of spinal injury, more especially wrenches or twists of the vertebral column, causing effusion into the structures that surround the nerves on their escape from it, and thus inducing compression of their trunks closely to their origin. The three nerves that are more commonly affected in this form of traumatic paralysis are the Sciatic, the Circumflex, and the Musculo-Spiral.

Traumatic paralysis of the *sciatic nerve* is commonly the result of sprain of the spine in its lower part. In it the whole nerve is rarely, if ever, implicated; but the loss of innervation, motor or sensory, is usually confined to one of its principal subdivisions: most frequently the external popliteal is the one affected. In consequence of this the foot is drawn somewhat inwards, drags on its outer side, cannot be properly everted, and thus the patient acquires a peculiarity of gait which is very characteristic. In walking, he does not advance the foot as far as the sound one; he brings it forward with a rotatory movement, drawing or dragging the foot along the outer edge and heel. The limb generally is weak, the patient being unable to stand on it alone; and most commonly it is the seat of neuralgic pains or of referred sensations of an intermitting nature.

Traumatic paralysis of the *circumflex nerve*, giving rise to loss of power in the deltoid and teres minor muscles, leads to a peculiar condition of the shoulder, that presents such very marked signs, taken collectively, that it cannot well be mistaken for or confounded with any other state.

In consequence of some slight injury of the shoulder, a strain or twist, a severe pain is experienced about the joint, followed by inability to use it freely. This disability increases until at last the arm cannot be raised from the side, whilst all the movements of the elbow, forearm, and hand, are perfect. On examining the shoulder, the following conditions will be found:—1. Atrophy of the deltoid to a greater or less extent; 2. Flattening of the posterior part of the deltoid; 3. Increased projection of the acromion; 4. The head of the humerus is thrown forward and somewhat inwards on to the inner edge of the glenoid cavity; 5. The brachial terminations of the greater pectoral muscle will be found to be very tense and unyielding. All movements about the shoulder, except those in a forward direction, are lost. The condition usually occurs in delicate people of lax fibres.

The atrophy of the deltoid is the primary condition, dependent probably on loss of power in the circumflex. In consequence of the loss of contractile power in the muscle, the antagonists and the pectoral especially are thrown into undue contractions. The consequence is, that the head of the bone is dragged forwards and subluxated.

The *Treatment* consists in first reducing the subluxation of the bone under chloroform; and after this has been done, in restoring the action of the deltoid by friction, douches, and galvanism.

The signs of paralysis of the *musculo-spiral* nerve, either as affecting the trunk or its primary subdivisions, have been so fully given at p. 416, that they need not be described here. They are necessarily the same in character, though they may vary in degree, whether associated with fracture of the humerus or not.

4. Traumatic paralysis from **section of a nerve** has been described at p. 347.

Diagnosis.—The diagnosis of these various forms of paralysis presents nothing that need at present detain us, as it is necessarily dependent upon, and in a great measure connected with, the cause of the affection —whether cerebral, spinal, or local. There is, however, one form of paralysis that is occasionally confounded with the traumatic varieties, more especially with that affecting the sciatic nerve, viz., the rheumatic.

Rheumatic Paralysis is a form of disease more frequently spoken about than met with—that is to say, if we apply the term paralysis to loss of nervous power independently of inability to use the limb from muscular weakness, rigidity, or pain, or from similar conditions connected with the joints. Yet there can be little doubt that rheumatic paralysis dependent on loss of nervous power really does exist; thus it commonly arises from cold in the facial nerve, and occasionally in the sciatic and its branches. It is difficult to assign a distinct pathological cause for it; most probably it is due to compression of the nerve by effusion within and around its sheath.

It is of importance to distinguish it from paralysis arising from other causes—more particularly from the traumatic forms. This may usually be very readily done by attending to two points: 1, that in the rheumatic paralysis we have, as a rule, co-existing or antecedent, an articular rheumatic affection of a chronic form; and 2, that in the rheumatic form of the disease the electric irritability of the muscles is not diminished, whilst in the spinal and local forms it is materially diminished, or may be, indeed, entirely absent.

TETANUS.

Tatanus is a disease consisting essentially in an excited state of the spinal cord and the medulla oblongata, in fact of the whole true spinal system, giving rise to painful and continued spasms of the voluntary muscles and the diaphragm, alternating with incomplete relaxation, and usually terminating fatally. This, which is one of the most serious and distressing diseases to which the nervous system is liable, is in the great majority of instances of a **Traumatic** nature, being the consequence of some wound that implicates or irritates a portion of the peripheral nervous system; the local irritation so produced being propagated to and affecting the nervous centres, the excitation of which becomes persistent, and continues after the local cause has been removed, inducing reflex muscular movements in various parts of the body The irritation of the nervous system, however, that induces tetanus, may arise from other sources besides surgical wounds, occasioning the **Idiopathic** form of the disease; thus, for instance, the presence of worms in the intestinal canal, exposure to cold and wet, the ligature of the umbilical cord in infants, and even the uterine irritation following abortion, have been known to occasion it. These causes, however, rarely give rise to it in

this country, and we must consequently regard it as a disease chiefly arising from traumatic lesion of some kind.

Causes of Tetanus.—Tetanus may occur at all *ages*, from the earliest infancy to an advanced period of life. In hot climates it is common amongst newly born infants, in the form of *Trismus Neonatorum*. In this country it rarely occurs at this very early period of life, but is common in young adults. I have most frequently observed it between the ages of 16 and 25, and after that in old people; but it may occur at any period of life. It is far more common amongst *males* than females—in the proportion of about four to one. *Season of the year* seems to exercise little influence over it. It occurs in all states of the atmosphere, and at all periods of the year; but is certainly most common when the weather is suddenly changeable—alternating from heat to cold. Indeed, long exposure to cold and wet, more particularly after the body has been heated, is the most common cause of tetanus when it occurs independently of surgical injury, and is a frequent predisposing cause in persons who have been wounded.

Tetanus may be occasioned by injuries that do not give ries to breach of surface; thus I have known it occur in a child who was suddenly thrown down upon its back by another at play, in a girl from a boy jumping on to her back, and in a lad by another striking him on the back by running a wheelbarrow at him; and Reid mentions a case produced by the stroke of a whip. But in the great majority of cases, it is directly occasioned by a *wound* of some kind. Generally a nervous twig has been lacerated, divided, or inflamed; and this seems to have been the starting point of that disturbance of the spinal system of nerves which leads to the tetanic spasms.

The *kind of wound*, as well as its situation, doubtless influences materially the occurrence of the disease. Though it certainly more frequently follows punctured, torn, and lacerated, than clean-cut wounds, yet it occasionally complicates these, even when they are made in surgical operations; thus, it has been known to follow the removal of the breast, amputation, the ligature of the larger arteries, and the operation for hernia. The minor surgical operations also are not free from the possibility of this dangerous complication. It has been observed after the operation for fistula in ano, the ligature of piles and varicocele, the removal of nasal polypi; and I have seen a fatal case resulting from the introduction of an issue. Burns are peculiarly liable to be followed by tetanus. It is the common belief, both in the profession and out of it, that wounds of the hands and feet, and more especially of the ball of the thumb and of the great toe, are more likely to be followed by tetanus than those in other situations. I think the truth of this opinion may be doubted; though it is not improbable that tetanus may occur more frequently after injuries of these regions than of other parts of the body, simply because punctured and lacerated wounds are more common here than elsewhere. It cannot well be supposed to be owing to the tendons and fasciæ that abound here, as Hunter imagined; for it is seldom, if ever, met with after operations for tenotomy, which are so commonly practised on the feet.

Tetanus may occur in all *constitutions*—in the strong and robust, and in the feeble and emaciated. It is especially apt, however, to occur in feeble and debilitated individuals, and, indeed, may be looked upon as a disease of debility; hence any condition that lowers the tone of the nervous system is especially likely to occasion it. When it occurs in persons who are otherwise strong and in the prime of life, it will be

found that they have been exposed to causes of depression influencing the nervous system. It is loss of nervous tone, and not muscular weakness that disposes to this disease. Thus, in tropical climates, as in some of the West India Islands, and amongst the marshes of Cayenne, it occurs with peculiar frequency, the most trifling scratches or punctures being followed by the disease. Poland, who has exhausted the statistics of tetanus, states that the mortality from it is in London .025, whereas in Bombay it is 2.5 per cent. of the total deaths. It is interesting to observe, that the natives of hot climates are far more liable to this disease than Europeans resident there.

In *military practice* tetanus is of common occurrence. Its frequency varies much in different campaigns and under different circumstances, season, and climate. In the Peninsular War it was estimated to occur in the proportion of about one case in every 200 wounded; in the Schleswig-Holstein war of 1849, according to Stromeyer, once in about 350 cases. In the Crimea it appears to have been of rare occurrence. Alcock's estimate of one to every 79 wounded is evidently too high. After naval engagements, however, the mortality has often been high, more particularly if they have taken place in tropical climates. Sir G. Blane states that, after Rodney's action in the West Indias, out of 810 wounded 20 were attacked with tetanus, being one in 40. All European Army-Surgeons are agreed, that sudden changes from heat to cold are amongst the most frequent causes of tetanus amongst the wounded. Thus Larrey states that, after the battle of Moskowa, although the number of wounded was immense, there were few cases of tetanus, the heat being very great and continuous; whilst after Bautzen, where the wounded were left on the field all night exposed to severe cold, more than 100 had tetanus; and after the battle of Dresden, when great heat was followed by much wet and cold, the wounded suffered most severely. So, after some of the Indian battles, as Chilianwallah and Ferozepore, where the wounded lay exposed to cold nights after very hot days (Macleod), tetanus was of very frequent occurrence. The case appears to have been different in America, where tetanus does not seem to have arisen from exposure of the wounded to cold and night air. Chisholm states that although, from the wooded nature of the country in which the battles were often fought, wounded men were not unfrequently left for two or three days on the ground, tetanus did not appear to be more frequent amongst them than in those immediately cared for. Hennen states that a draught of air, whether hot or cold, directly blowing on the patient, is the most fertile cause of tetanus

The frequency with which tetanus occurs varies much. It often happens that not one case occurs in a hospital for some years, and then several are met with in close succession or simultaneously.

Period of Occurrence.—Tetanus may take place at any period after the infliction of the wound that occasions it. In hot climates especially, it may occur very speedily; thus, Robinson relates the case of a negro servant in the West Indies, who scratched his finger with a broken plate, and died of tetanus in a quarter of an hour. It is very seldom, however, in temperate climates, that it supervenes before the fourth or fifth day, usually from that to the tenth day. Larrey, who had great experience of this disease during Napoleon's campaigns in Egypt, met with it most frequently between the fifth and fifteenth days after the infliction of the wound. According to the experience of the Surgeons of the Peninsular War, under whose observation many hundred cases came, the disease does not show itself after the twenty-second day; but, though

this may be the general rule, Sir G. Blane has related a case in which it took place as late as a month after the infliction of the wound. It is stated that it may occur after the cicatrisation of a wound is completed; when this happens the disease must be looked upon as being idiopathic, accidentally occurring in a person who has been recently injured.

Forms.—Tetanus may be *Acute* or *Chronic*; being in some instances fatal in the course of a few hours, but usually lasting for three or four days. Poland states that at Guy's 51 per cent. of the cases were fatal before the fifth day after invasion. If the patient survives this time, the disease will commonly run on to the eighth or tenth day, and occasionally even for a longer period than this; thus, S. Cooper mentions a case in which it continued in a soldier for five weeks after amputation. The more chronic it becomes, the better is the chance of recovery; indeed, if the patient survive the tenth day, the prospect of a favorable issue to the case is materially increased. As a general rule, those cases are the most fatal which are most active in their symptoms; the danger being in the ratio of the acuteness of the attack, both as to severity and also as to rapidity of invasion after injury.

Symptoms.—The invasion of the disease is sometimes preceded by a general uneasiness on the part of the patient, a feeling of illness or weakness, or a sense of impending mischief. Abernethy was of opinion that tetanus was usually ushered in by a disturbed state of the digestive organs, the stools being offensive and indicative of much gastric irritation. When the disease sets in gradually, it may be somewhat difficult of recognition in its early stages; if it come on suddenly, its nature is immediately evident. It is a remarkable fact that the cramps do not begin in the part injured; but, wherever this may be situated, they are always first noticed in the muscles of mastication, of the face, and upper part of the neck; and throughout, these and the muscles of the respiration are principally affected. In tetanus, the circle of nervous disturbance is at first very limited. It is confined to the muscles supplied by the motor branch of the fifth, by the portio dura of the seventh nerve, and by the spinal accessory. These nerves appear to be alone affected; the sensory division of the fifth is never influenced throughout the disease. The spasm may be confined to the muscles supplied by these nerves, as is the case in trismus; but it soon spreads to the true spinal nerves, being, however, confined to their motor divisions. The first symptoms usually consist in the patient feeling a stiffness or soreness about the jaws and throat, being unable to open his mouth widely, to take food or drink, the muscles about the temples, jaw, and neck feeling stiff and rigid; this condition has given to the disease the popular term of *lock-jaw*. As the affection advances, the countenance assumes a peculiar expression of pain and anguish, the features are fixed or convulsed from time to time, and the angles of the mouth drawn up, constituting the appearance called the *risus sardonicus*. When fairly set in, the disease is marked by spasms of the voluntary muscles of the most violent character, with much pain and only partial remissions. The pain is of that kind that attends ordinary cramp in the muscles, as of the legs, and is usually very severe. The spasms are often jerking, the patient being suddenly thrown up or twisted on one side; the breath is drawn with a loud sobbing catch from spasm of the diaphragm, and from the same cause there is usually violent pain experienced in the epigastric region, darting across to the spine. The muscles of the trunk are usually affected next in order of frequency to those of the head and neck, the body being bent backwards so as to form a complete arch (*Opisthotonos*);

more rarely is it drawn forwards (*Emprosthotonos*); and still less frequently to one side In some cases the body becomes perfectly rigid, like a piece of wood, the belly being drawn in, and the chest expanded. It is said that in severe cases the spasms have been so violent that muscles have been ruptured, teeth broken, and the tongue lacerated. In the numerous cases of tetanus that I have unfortunately witnessed, it has rarely fallen to my lot to see any effects of this kind produced; the spasms, indeed, being in general not very violent, though continuous and very painful. The only muscles that I have seen torn have been the recti of the abdomen.

The intellectual faculties are not disturbed, and the mind continues clear to the last. Cases of tetanus occasionally prove fatal without any elevation of temperature; but in most instances there are great heat of surface, profuse sweats, and quickness of pulse; not so much from any febrile disturbance, but apparently from the violence of the muscular contractions. In most cases this symptom is peculiarly marked, especially towards the end of the case, when the temperature may rapidly rise to extraordinary heights. Thus, Wunderlich has recorded a case in which it reached 112.55° Fahr. immediately before death. It may continue to rise a few tenths of a degree higher after death in these cases. The prolongation of life appears to depend greatly upon the intensity of the convulsive movements; the more severe these are, the sooner does death result. The fatal termination occurs not so much from any great physical lesion, or disturbance of important parts, as from exhaustion consequent on the frequency of the tetanic spasms.

Pathology.—There is surely nothing more remarkable in the whole history of disease than that, in consequence of a trivial wound inflicted on a distant part of one of the extremities of the body, an otherwise apparently healthy man should be seized with a spasmodic affection of the muscles of the jaws; that this spasm should extend to the trunk; and that after a few hours it should be followed by general convulsive movements which will, in the great majority of instances, speedily end in death It might reasonably be expected that such a train of phenomena would leave the most unmistakable evidences of the conditions that had given rise to them; and that pathological anatomy would at once, and in the clearest manner, enable us to unravel the mysterious bonds that connect a graze of the foot with a spasm of the muscles of the neck and jaw. But in this we shall be grievously disappointed; for the morbid appearances found after death from tetanus throw but little light on the real nature of this affection,—so little, indeed, that it is frequently looked upon as a "functional disease." But in saying that this or any other disease is functional, we only express our ignorance of its real cause. There is no function without an organ to perform it; and there can be no derangement of a function without a corresponding and concomitant disorder of the organ that produces it. Every "functional" disease must, therefore, at last be referred to an organic lesion. The term "functional" is only employed when we are not acquainted with the true nature of the disease. As less is known of the real physiology and pathology of the brain and spinal cord than of other organs of the body, we have more "functional" diseases of the nervous system than of the circulatory or respiratory. But, as pathological anatomy becomes more studied, and as minute investigations into structure are entered upon, so the class of so-called "functional" diseases becomes narrower. We do not speak of "functional" coma, because we can appreciate the different conditions that occasion compression of the brain; but we still

speak of functional convulsive diseases and of functional amaurosis. The ophthalmoscope, however, has shown that "functional" amaurosis does not exist, but that the failure of visual power is always accompanied by and dependent on some corresponding change of structure in the interior of the eye; and advances in pathology will doubtless show that other so-called functional diseases of the nervous system are in reality dependent on structural lesions.

State of the Nerves at the Seat of Injury.—There is one morbid condition that will, I think, invariably be found in tetanus, viz., a marked congestion and inflammation of the nerve connected with, and leading from, the wound that has occasioned the disease. This morbid state I have never found wanting. In all cases of fatal tetanus that I have seen in which a careful dissection has been made, the signs of inflammation of a nerve communicating with the wound have been found; and the vascularity, which is often very intense, may be traced up the neurilemma, often to a considerable distance In a case of tetanus following a wound of the knee, in a patient who died in University College Hospital, a small branch of the internal cutaneous nerve was found to have been injured, and was inflamed. In another patient who died of tetanus about sixteen days after treading on a rusty nail, a black speck was found on the internal plantar nerve, where it had been wounded by the nail. In a man who died of acute tetanus a week after receiving a lacerated wound of the dorsum of the foot, the digital nerves were found to be sloughy, and evidences of inflammatory irritation extended some distance up the musculo-cutaneous nerve. In another case under my care, in which tetanus resulted from a bruise of the back, and terminated in death, the injured nerve (a dorsal branch) was found lying bare and reddened in the wound; and, on tracing it up to the spinal cord, its sheath was found to be much injured, ecchymosed, and with a large vessel running down it. In another instance, in which tetanus followed a wound of the wrist, the external cutaneous nerve was found in a similar inflamed state.

The Pathological Conditions found in the Spinal Cord in cases of tetanus have been studied by Rokitansky, Lockhart Clarke, Dickinson, and Allbutt. Rokitansky described them as consisting chiefly of a proliferous development of connective tissue, composed of young cells. Billroth doubts the correctness of this observation; and many competent observers have failed to discover anything more positive than ecchymosed patches and interspaces in the spinal medulla. Lockhart Clarke has in at least six cases observed lesions of structure in the spinal cord, consisting of disintegration and softening of a portion of the grey substance of the cord, which appeared in certain parts to be in a state of solution. The fluid thus formed was in some parts granular, holding in suspension the fragments and particles of the disintegrated tissue, but in many places it was perfectly pellucid. He considers this due to hyperæmia of the cord, accompanied by exudation and disintegration. Dickinson has described intense hyperæmia with a structureless exudation poured out around the vessels in many parts of the grey matter, breaking down the surrounding tissue. He also observed some hæmorrhages in the white columns. These observations have been confirmed by Clifford Allbutt, who found in four cords which he examined that the tissues were intensely congested, and surrounded by spaces containing a structureless exudation, especially in the grey matter. The absence of any constant and distinct pathological lesion has led to the hypothesis of tetanus being dependent primarily on blood-

poisoning, and not on a lesion of the nerve-centres. Billroth, who inclines to this idea, admits that it is a mere hypothesis. This theory of blood-poisoning being the primary cause of tetanus is based on the following line of argument. A septic agent, capable of producing convulsive movements when absorbed into the blood—of acting, in fact, like strychnia—may be supposed to be generated in certain circumstances, whether of individual predisposition or of epidemic constitution, in the wound or at the seat of injury. We have the analogy of hydrophobia in support of the idea that, in certain circumstances, such an agent may be generated in the system, rendering the fluids—blood and saliva—poisonous to others, and capable of developing a convulsive disease in the animal affected. We have, however, no evidence as yet that the blood or any one of the secretions of a tetanic patient is capable, when inoculated, of producing a similar disease in a healthy animal.

There is one objection to this theory which appears to me too serious to be overlooked: viz, that tetanus has been arrested, if not cured, by the division of the principal nervous trunk leading from the seat of injury, as the posterior tibial nerve in cases of tetanus arising from wound of the sole of the foot. This fact appears to me to point rather to a primary nervous lesion than to blood-poisoning as the exciting cause of the tetanic convulsions.

Treatment.—The treatment of tetanus is of a local and of a constitutional character. The **Local Treatment** has for its object the removal of the irritation that has induced the tetanic condition. It is true that, when once tetanic excitement has been set up in the cord, it has a tendency to continue, and to be incapable of removal by the mere abstraction or cessation of the local irritation, which gave rise to it in the first instance. It is, however, only reasonable to suppose, that other treatment will succeed best if local irritation be removed; and, indeed, so long as this continues to keep up the centric nervous disturbance, no general means can be expected to succeed; as they will have not only to combat already existing disease, but also to overcome the continuous excitement maintained by the local disturbance. Hence it is of importance to bring the wound into as healthy a state as possible, and to see that it is clean, free from foreign bodies, and not inflamed. In order effectually to remove all local disturbance, recourse has been had to amputation; but though this may have succeeded in checking some of the more chronic forms of the disease, yet other and milder local means have sufficed equally well, and in the majority of cases it has had no effect, and hence so severe an operation can scarcely be recommended for adoption. The division of the trunk of the injured nerve, at some distance above the wound, if there be one that has been punctured or lacerated, has occasionally proved successful. Thus, in a case of tetanus following injury of the supraorbital nerve, Larrey cut this across, and the patient was cured. In a midshipman, in whom tetanus came on the day after the sole of the foot had been wounded by treading on a rusty nail, Murray divided the posterior tibial nerve, and thus cured the patient. In those cases in which no special nerve appears to have been injured, Liston's recommendation of making a Λ-shaped incision down to the bone, and above the part, so as to insulate it completely, may be advantageously followed. After the nerve has been divided, or the part properly insulated, some solution of atropine may be carefully applied to it, so as still further to lessen local irritation.

In the **Constitutional Treatment** of the disease, it is necessary to bear in mind that tetanus is an affection of debility, the violence of the

spasmodic paroxysms giving an appearance of false strength to the patient; and that the principal source of danger and death is the fatigue and exhaustion induced by the energy of the muscular movements. The means adopted should, therefore, have for their object the removal of irritation and the support of the patient's strength, so as to enable him to hold up against the disease.

Nothing can be more unsatisfactory than the treatment of the *Acute* form of traumatic tetanus. In it, all medicines are useless as curative agents. But, though medicines are of no avail as means of cure, they may act as palliatives, and afford relief to the patient; and much may be done by the Surgeon, by removing all sources of external irritation, to mitigate his sufferings, and to place him in a favorable condition to withstand the exhaustion, and to lessen the torture of the spasms. With this view, the first thing to be done is to clear the bowels well out with an aperient dose; aided, if necessary, by a turpentine enema. The patient should then be kept perfectly quiet in a room by himself, a screen or muslin curtains, as recommended by Marshall Hall, being drawn round the bed, as noise or movement of any kind increases the spasms greatly. In order to allay the spinal irritation, the most effectual means consists perhaps in the plan recommended by Todd, of applying ice along the whole length of the spine: this is best done by one of Chapman's spine-bags. This is a powerful depressing agent, and, unless care be taken, may lower the heart's action too much, or indeed completely extinguish it. It may, however, be applied with safety for six or eight hours, the condition of the patient being looked to in the meanwhile. Sedative or antispasmodic agents are of no use whatever in acute traumatic tetanus. I have seen many drugs of this kind employed, without producing any effect in lessening the violence of the convulsions. In most cases, however, the inhalation of chloroform, or the administration of chloral, materially lessens their severity, and gives the patient at least temporary ease.

In the *Subacute* or *Chronic* form of the disease, recovery is much more likely to take place; and it is only in these cases that antispasmodics and sedatives have been of use, and in these also chloroform and chloral are far more beneficial than in the acute cases. There is a kind of trismus occurring in females, often of a hysterial nature, which is at once removed by the inhalation of chloroform. Almost every drug in the pharmacopœia of a tonic, sedative, or antispasmodic nature, has been employed in these cases; and the recovery which has occasionally resulted has been perhaps over-hastily attributed to the remedy, rather than to the employment of those dietetic and hygienic means, which are of the first importance, by enabling the patient to live on until the disease wears itself out. Tonics, especially iron and quinine, have been employed by some. Elliotson was strongly impressed with the value of the carbonate of iron. Sedatives in all forms—conium, belladonna, opium, and their alkaloids—have been largely and most ineffectually employed. Miller speaks highly of cannabis Indica pushed to narcotism, three grains of the extract, or thirty minims of the tincture, being given every half hour or hour; and Haughton has employed nicotine in one-drop doses, administered every second hour, with complete success in severe cases of traumatic tetanus.

The Calabar bean is the best remedy that perhaps deserves physiologically the most attention; for, as it is nearly if not quite antagonistic to the tetanic spasms of strychnia, it may be hoped that it will be found equally useful as a sedative to the spinal cord in those arising

from traumatic causes. In E. Watson's hands, very successful results have followed its administration. Yet it is far from being a specific. I have tried it in several cases, with no appreciable good effect. It may be given by the mouth, hypodermically, or *per anum:* in the form of a solution or a tincture of the extract in half-grain doses, by the mouth; hypodermically, in doses of one-sixth of a grain; *per anum*, in grain-doses. The dose should be given at least every second hour, until complete contraction of the pupil occurs. Stimulants, as brandy, should at the same time be given to counteract the depression that will result from the use of the drug. At the same time that recourse is had to such measures as these, it must not be forgotten that the disease is one of great exhaustion, and that the patient will die worn out, unless he be supplied with plenty of nourishment. Beef-tea and wine should, therefore, be administered by the mouth, as long as the patient can swallow, and nutritious enemata by the rectum; and in this way the powers of life may be supported until the violence of the disease expends itself. I am, however, disposed to think that even in these chronic cases much more may be done by simple than by specific treatment. Clearing out the bowels by a turpentine enema, breaking the violence of the spasms and giving the patient rest and ease by chloroform inhalations or by chloral enemata, and keeping up the powers of the system by injections of beef-tea, egg, and brandy into the rectum, till the disease wears itself out, appear most likely to be followed by a satisfactory result, when used in addition to the hygienic measures recommended in the acute form of the disease. It is certainly more rational to employ such measures as these, than to be constantly recurring to antispasmodics and sedatives, which repeated experience has proved to be useless as curative agents, in the vain hope of finding a specific for tetanus.

CHAPTER XXXIX.

DISEASES OF THE LYMPHATICS AND THEIR GLANDS.

INFLAMMATION OF THE LYMPHATICS.

Inflammation of the Lymphatics, Lymphatitis, or **Angeioleucitis,** is a diffuse or erysipelatous inflammation of the lymphatic vessels. In it, according to Tessier, the lymph coagulates, forming a rosy clot, which obstructs the interior of the vessels; the walls of which, at the same time, become thickened, softened, opaque, and surrounded by a quantity of infiltrated areolar tissue.

Symptoms.—This disease may be idiopathic, when it is closely associated with erysipelas; but more commonly it is set up from the irritation induced by an infected abrasion or wound. During the progress of an ordinary injury, the patient is seized with rigors, followed by febrile reaction, and attended, perhaps, by vomiting or diarrhœa. These symptoms often precede by twelve or fourteen hours the local signs of the disease, but more commonly accompany them. On examining the part it will, if superficial, be seen to be covered by a multitude of fine red streaks, at first scattered, but gradually approximating to one another so as to form a distinct band, about an inch in breadth, running from

the part affected along the inside of the limb to the neighboring lymphatic glands, which may be felt to be enlarged and tender. The band itself feels somewhat doughy and thickened. Sometimes one lymphatic can be felt hard and isolated like a piece of whipcord. There is usually more or less œdema of the limb, from the implication of the deeper layers of vessels and their obstruction by the inflammation. Along the course of the inflamed absorbents, erysipelatous-looking patches not unfrequently appear, and coalesce until they assume a considerable size, and constitute a distinct variety as it were of erysipelas. In some cases the glands are affected before any other local signs manifest themselves, owing probably to the deeper seated lymphatics having been first implicated; or possibly by the direct absorption of and deposit in them of some septic matter that constitutes the primary source of the infective inflammation; and not uncommonly throughout the disease the inflammation continues to be confined principally to this set of vessels, giving rise to great and brawny swelling of the limb, but without much if any superficial redness. The constitutional disturbance, at first of the active inflammatory type, may gradually subside into the asthenic form.

The Diagnosis of inflammation of the lymphatics has to be made in its primary state from phlebitis and erysipelas; in its secondary from pyæmia. From phlebitis, the diagnosis is easy by attention to the superficial redness of lymphatitis, and the absence of the cord-like plugged vein. From erysipelas, the absence of the diffuseness of the red blush, and its limitation to the course of the inflamed absorbents, will readily serve as diagnostic signs. But into erysipelas the lymphatitis may ultimately run. From the pyæmic it is necessary to diagnose the acute lymphatic abscess. This is usually easy; the lymphatic abscess being, if deep, solitary; if superficial and multiple, confined to the tract of the previously inflamed absorbents: in either case being always between the starting point of the primary source of irritation or wound and the glands; in the calf, thigh, or iliac fossa, if the primary irritation be in the lower extremity, in the axilla or side if in the upper. The symptoms also indicative of prostration, of hectic, &c., are totally unlike those of true pyæmia.

Results.—The disease usually terminates in resolution at the end of eight or ten days; not uncommonly it runs on to erysipelas; and in other cases, again, localised suppuration may take place, sometimes in the form of one large deep-seated abscess in the upper part of the limb or in the thigh if the lower extremity, or under the pectorals and in the axilla if the upper extremity be the seat of irritation; or a chain of abscesses may form along the course of the inflamed absorbents and in the glands to which they lead. In some instances, after the disappearance of the disease, a state of chronic and rather solid œdema of the part may be left, giving rise indeed to a species of false hypertrophy, and constituting a troublesome consequence; more rarely, death results from more or less general blood-poisoning. This may assume the form of a local development of cellulo-cutaneous erysipelas, or may lead to genuine pyæmia. If abscess form, irritative fever, with much wasting, anæmia and pallor may set in; and death may ultimately ensue as the consequence of hectic and exhaustion.

Causes.—The cause of inflammation of the absorbents is septic irritation introduced from without or generated by morbid constitutional states; the disease is especially disposed to by atmospheric vicissitudes, by particular seasons of the year, more especially the early spring, and by the epidemic constitution at the time tending to disease of a low

type. Broken health and the neglect of hygienic precautions also tend to induce it. Amongst the more direct causes are wounds of all kinds, but especially such as are poisoned by the introduction of putrid animal matters or other irritants, or that are of recent origin. It is very rarely indeed that inflammation of the absorbents occurs without some such external cause; yet we are certainly warranted in considering it as of idiopathic origin in some instances. I have at least seen cases in which careful examination has failed in detecting any breach of surface or evidence of poisonous absorption.

TREATMENT.—In superficial lymphatic inflammation of the skin and integumental structures, the local application of belladonna, as recommended by C. Heath, is the most efficient agent in subduing the local action; a paste of equal parts of the extract and of glycerine should be thickly smeared over all the inflamed parts, and followed by assiduous poppy fomentations; the limb at the same time being kept elevated. The bowels should be freely opened. If chronic induration and œdema occur, the application of blisters will be found to be of use in taking down the swelling and hardness; bandaging, so as to compress the limb methodically, may be of service in the later stages. If abscesses form, these should be opened early, and treated on ordinary principles.

INFLAMMATION OF LYMPHATIC GLANDS.

Inflammation of the Lymphatic Glands, or **Adenitis,** may occur from the extension of inflammation along the course of the lymphatics; from the irritation induced by acrid or poisonous substances conveyed along these vessels, and not inflaming them, but inducing diseased action in the glands through which they are carried; or as a consequence of strains resulting from over-exertion, as is often seen in the glands of the groin from walking too much. In whatever way occurring, inflammation of the absorbent glands is always attended by a stasis of the lymph, with coagulation of it; and, if the whole or greater part of the glands of a limb be affected, the course of the fluid through the absorbent vessels may be so seriously interfered with, that œdema, often of a solid character, occurs in the lower parts from which the lymph ought to have been conveyed.

VARIETIES.—Adenitis may be acute, subacute, or chronic. In **Acute Adenitis,** which almost invariably occurs as a consequence of angeioleucitis, there are pain, swelling, tenderness, and stiffness about the affected glands, with a dull, heavy sensation in them, followed by all the signs of acute abscess, the glands gradually softening in the centre, and the suppurative inflammation extending to the contiguous areolar membrane, through which it becomes somewhat diffused. In **Subacute Adenitis,** which is a common result of injuries or strains, the glands become swollen, enlarged, and tender, and are matted together by the inflammatory and plastic consolidation of the neighboring tissues. If abscess form, it commonly commences in the structures around the glands; and these are perhaps eventually exposed at the bottom of the cavity that results. This is especially apt to happen in cachectic and strumous persons from slight sources of irritation. Very commonly, in such subjects, the inflammation of the glands runs into a **Chronic** state; which, indeed, may at last terminate in their permanent enlargement and induration, or in tuberculous degeneration. When the glands become chronically inflamed from the first, they are enlarged and hardened, with tenderness and pain about them: after a time suppuration takes place

within them; or perhaps it may occur in the areolar tissue around them, which, breaking down, leaves them in the form of reddish-grey or fleshy masses, that protrude in the midst of the suppurating cavity: as the inflammation subsides, the skin becomes of a reddish-blue or purple hue, is thinned, and firmly incorporated with the subjacent tissues.

scrofulous

Strumous Enlargement of Glands.—The glands not uncommonly enlarge *chronically* without inflammation, simply as the result of strumous disease or of chronic irritation of some kind. They may remain permanently enlarged, or, after continuing so for months or years, may slowly break down into unhealthy suppuration, leaving the skin thin, blue, and undermined, with weak and often protuberant cicatrices. The pus is curdy and ill-conditioned. In all probability, the peculiar enlargement and tendency to unhealthy suppuration arise from the deposit of tuberculous matter within the gland. These changes principally occur in the neck, especially in the submaxillary glands and the glandulæ concatenatæ, sometimes in the axillary or inguinal glands, forming large indurated and nodulated tumors matted together, and suppurating in the interstices of the areolar tissue, or in the substance of the glands themselves. This strumous enlargement of the glands occurs chiefly in children and in young people; in whom, indeed, it is commonly looked upon as one of the most frequent accompaniments of the strumous diathesis.

TREATMENT.—The treatment of inflamed absorbent glands varies greatly, according to the stage of the affection. In the *acute stage*, leeches and fomentations are especially required. In the *subacute* condition, spirit-lotions containing the iodide of potassium will subdue the inflammation and take down the swelling; at the same time, the health must be regulated by aperients, and a moderate antiphlogistic plan of treatment. If an abscess form, it must be opened with a knife, and the part well poulticed afterwards; the fistulous openings, which are often left, require to be treated by stimulating applications, especially the nitrate of silver, but very commonly they will not heal unless they are slit up and dressed from the bottom.

Chronic Inflammation with Hypertrophy of the Lymphatic Glands, or the induration left as the result of the acute disease, requires to be treated on different principles. If there be any pain and tenderness about the glands, the application of the iodide of potassium and spirit-lotion will be required. If they have already suppurated, and an aperture exist leading down to an indurated mass, or if there be surrounding induration of the soft tissues, it is often a good plan to rub the ulcerated part freely with caustic potash, which will dissolve it away by exciting inflammation around the plastic deposit, and thus causing its dissolution into pus. When there is merely chronic enlargement, without irritation, methodical friction with iodine or iodide of lead ointment will produce absorption of the inflammatory effusion constituting the bulk of the enlargement; and this in many instances may remove the tumor entirely. In other cases, painting the part with the tincture of iodine, and improvement of the general health, will cause the removal of the diseased structure. After abscess has formed and been opened, fistulous openings will be left, into which large masses of hypertrophied gland may be seen to project. These are best reduced by the red oxide of mercury, or potassa fusa: indeed, if the glands be much enlarged and indurated, projecting into the openings made over them, the potassa fusa is the best application that can be made use of, breaking down and dissolving away the indurated mass. In applying it, care

= Pseudo-leucocythaemia =

must be taken that the caustic do not spread too widely; this may usually be avoided by coating the surrounding integuments with collodion. Extirpation of enlarged lymphatic glands is seldom necessary, and, if undertaken, may lead to more serious and extensive dissections than might appear at first requisite; for a chain of diseased glands often extends to a considerable distance, and after one has been removed, others come into sight. As a general rule, this operation should not be undertaken: cases, however, occasionally occur, in which such a procedure may be deemed advisable, the affected glands being large and indurated, and their disease of many years' standing; their extirpation may then be proper, and I have not unfrequently had occasion in such circumstances to remove them from the axilla, from the submaxillary region, and from the posterior triangle of the neck.

When the strumous diathesis is well marked the constitutional treatment recommended in the Chapter on Scrofula and Tubercle must be employed.

The lymphatic glands occasionally become much enlarged in the neck, axilla, and groin without any indications of struma, but attended by much debility, and usually great emaciation; in these circumstances, the best remedies are liquor potassæ in full doses, iodide of iron, and cod-liver oil.

OTHER DISEASES OF LYMPHATICS AND THEIR GLANDS.

LYMPHADENOMA, or, as it is also called, **Simple Lymphoma** or "Hodgkin's disease," is a tumor composed of a tissue exactly resembling the cortical part of a lymphatic gland—the so-called "adenoid tissue of His." It usually grows from pre-existing lymphatic tissue, and the situations into which it most commonly comes under the observation of the Surgeon are in connection with the lymphatic glands of the neck, axilla, or groin. These tumors are also not uncommonly found in the upper part of the pharynx, growing from the lymphatic follicles in that region. They may be single, and are then usually of considerable size; but they may affect all the lymphatic glands, the liver, spleen, kidneys, &c., at the same time. This condition may be accompanied by an excess of white corpuscles in the blood, constituting the disease known as leucocythæmia; or this symptom may be absent, constituting the disease described by Trousseau under the name of *Adénie*. The enlargement is not accompanied by pain or inflammation.

These tumors may vary in size from a millet-seed to a fœtal head. Several such tumors may unite together, forming a single mass; if situated in the neck or in connection with the bronchial glands, they may cause death by pressure on the trachea. They are usually well defined; but they are described by Billroth as occasionally invading the surrounding tissues, then forming the so-called malignant lymphomata. Such cases are always fatal by marasmus and anæmia. Billroth describes lymphoma as occurring also in tissues not belonging to the lymphatic system, as in the jaw, scapula, and areolar tissue.

Structure.—In the lymphatic glands, lymphadenoma resembles simple hypertrophy; but on section it will be found that all distinction between cortical and medullary parts is lost, the whole mass being composed of tissue resembling the cortical part. On section, lymphadenoma much resembles medullary cancer; it is soft, greyish in color, with spots of red, due to hæmorrhages or dilated vessels; and opaque or cheesy spots may be scattered through it. It yields a juice on scraping, like cancer-juice. The juice obtained by scraping a lymphadenoma is found, with the aid

of the microscope, to be composed of innumerable round cells, having the size and appearance of lymph-corpuscles or the white corpuscles of the blood. On examining the tumor by means of sections made from hardened specimens, a delicate reticulate stroma is seen, the meshes of which are filled with the cells found in the juice above mentioned. The stroma can only be seen clearly by washing out the cells, either by shaking the section in water or brushing it with a camel's-hair pencil. (Fig. 288.)

The Causes of lymphadenoma are very obscure. It affects both sexes, and is chiefly met with in young adults. Its immediate origin may sometimes be referred to prolonged fatigue, extreme muscular exertion, or residence in low and damp localities;—to those various conditions, indeed, that necessarily lead to deteriorated health and imperfect nutrition.

The *Diagnosis* of these tumors, when in the lymphatic glands, from chronically inflamed glands, is impossible in the early stages. It is only when their power of continuous and multiple growth becomes apparent that we call them lymphadenomata.

The *Treatment* of lymphadenoma is in the highest degree unsatisfactory. Iodine, often applied locally in a routine manner, is absolutely useless, and no other external application appears in any way to promote the absorption of the mass. The constitutional treatment resolves itself into the employment of measures to combat the anæmia, and improve the nutrition of the system. With this view, iron, cod-liver oil, and continuous residence in bracing health-resorts, are serviceable.

The question of the removal of the mass by operation must be discussed. If the tumor be large and single, or composed of an agglomeration of multiple masses, and so situated that it can be taken out with safety, its removal is proper, and should be practised. I have several times removed large lymphadenomata from the axilla and upper part of the neck with great advantage. Even when the disease is multiple, single large masses that are sources of special trouble should be dissected out. In one such case a tumor, which was as large as a fist, was removed, in University College Hospital, from the axilla. The patient, a delicate woman, had a group of similar growths in the neck, which had remained stationary for twenty years.

Elephantiasis of the Legs and Scrotum.—Elephantiasis Arabum, or, as it is often called, the **Barbadoes Leg**, is an affection that is common in many tropical countries, in the West Indian Islands and in South America more particularly. It is met with, though comparatively rarely, in Europe. The disease usually affects one of the lower extremities (seldom both), the scrotum, or the labia, which may become enormously enlarged and hypertrophied. In the face it is often met with; in the upper extremities rarely.

It is not my intention to enter into an account of the history, the symptoms, or the causes of this remarkable malady. It is sufficient for my purpose here to say, that it appears to consist in disease primarily seated in the lymphatics. The glands, as Virchow and Rindfleisch suppose, become impervious to the transmission of lymph, and the hyperplastic deposits that characterise the disease are the consequence, together with the general stretching and hypertrophy of the integumental structure, of the plastic effusion into the areolar tissue.

Treatment.—When this disease attacks the face, little, if anything, avails in the way of treatment. When it affects the labia and scrotum, the enlarged and diseased part must be removed. But when the leg is affected, surgery can effect much in the way of cure. In the slighter

cases much may be done by elevation of the limb, methodical bandaging, and perhaps, as Rayer and Lisfranc recommend, the employment of scarification. But in the more severe cases, where the limb has swollen to a monstrous size, and has become shapeless from the groin to the ankle, the skin sallow, covered with nodules and overlaid by a branny desquamation, with a tendency to unhealthy and incurable ulcerations—in these advanced and serious cases, more active measures are necessary.

Fig. 331.—West Indian Elephantiasis.

Dufour seems to have been the first to propose diminution of the supply of arterial blood to the limb as a cure for this disease. This he effected by compressing the femoral artery by means of a kind of truss, and was successful in four cases. This practice of compression has since been successfully followed by Hill, Cockle, Vanzetti, and others.

TABLE I.

Table of Ligature of Femoral Artery for Elephantiasis.

SURGEON.	SEX.	AGE.	SEAT AND DURATION OF DISEASE.	RESULTS.
1. Carnochan .	M.	27	Right lower limb. 6 months .	Cure permanent.
2. " .	M.	30	Left leg. 6 years; many ulcerations	Relapse after 14 mos.
3. " .	F.	25	Right lower limb. 5 years .	Cure.
4. " .	F.	26	Both lower limbs. 5 years .	Right femoral tied in Jan.; left in April, 1858. Great improvement in both limbs.
5. Ogier . .	M.	26	Leg and foot. Several years .	Cure.
6. Butcher .	F.	44	Right leg. 18 years . . .	Operation very difficult. Cure after 4½ years.
7. Richard .	F.	28	Left lower limb. 13 years .	Cure.
8. Fayrer .	M.	30	Right leg. 7 years	Death from pyæmia on 18th day.
9. " .			Right leg	Death.
10. Alcock . .	M.		Leg ulcerated. 2 years . .	Improvement.
11. H. Watson.	M.		Leg	Improved.
12 Vanzetti .	F.	21	Right lower limb. 7 years .	Cure after 3 years.
13. T. Sympson	F.	41	Left lower limb. 31 years .	Improved for a time, but recurred. Amputation 9 years afterwards.
14. Baum . .	M.	31	Left lower limb. 13 years .	No benefit.
15. " . . .	F.	38	Left leg. 33 years	Gangrene.—Death.

TABLE II.

Ligature of the External Iliac for Elephantiasis.

SURGEON.	SEX.	AGE.	SITUATION AND DURATION OF DISEASE.	RESULTS.
1. T. Bryant .	F.	25	Left lower limb. 10 years after scarlatina	Cure after 7 months.
2. G. Buchanan	F.	17	Left lower limb. 5 years . .	Temporary improvement. Relapse after 11 months.
3. C. Hueter .	F.	23	Left lower limb. 8 years . .	Cure.
4. Simon . .	F.	20	Left lower limb. 4 years. Right limb slightly affected, 1 year	Left external iliac tied Temporary benefit. Relapse in 8 mos.

TABLE III.

Ligature of other Arteries for Elephantiasis.

SURGEON.	SEX.	AGE.	SITUATION AND DURATION OF DISEASE.	RESULTS.
1. Statham . .	M.	42	Foot and ankle	Anterior tibial tied in middle third of leg. Improvement.
2. Carnochan .	F.	42	Elephantiasis Græcorum. Face enormously swollen	Right common carotid tied. After 6 mos. left common carotid tied. Some nodules removed. Cure after 8 years.

To Carnochan is due the merit of having recommended the ligature of the femoral artery as a means of cure in these cases; and, in whatever way it acts, there can be no doubt of the excellent effects that have followed this method of treatment, little as it can be explained by the received pathological views of the disease. In some instances, as by Bryant, Buchanan, and Simon (of Heidelberg), the external iliac has been advantageously tied. The operation on this artery has the recommendation not only of being completely above the limits of the disease, and consequently in parts that are quite healthy, but also of more completely controlling the nutrition of the limb than can be done by ligature of the superficial femoral.

The result of the operation appears to have been fairly encouraging in a certain number of cases, though in a large proportion it is evident, by the above tables, that little if any improvement took place. Much doubtless depends on the real nature of the disease—whether true elephantiasis, or simple enlargement of the limb from the deposit of lowly organised plastic deposit of a less specific character. The latter probably undergoes absorption, when the nutritive supply of blood has been cut off, much more readily than the former.

Varix of the Lymphatics has been occasionally met with, both in the superficial and deep networks and in the lymphatic trunks. The part most commonly found affected has been the inner side of the thigh; but the disease has also been seen in the anterior wall of the abdomen, about the ankle and elbow joints, and on the prepuce. In the superficial lymphatics, the varix first appears in the form of small elevations, giving the skin an appearance which has been compared to the rind of an orange; it subsequently takes the form of little vesicles covered with a thin layer of epidermis. Varix of the larger lymphatic trunks frequently accompanies the condition just described. The vessels may either be dilated cylindrically into round beaded enlargements, often semi-transparent, and but slightly compressible; or ampullæ may be formed on them, giving rise to more or less soft swellings, fluctuating under the finger. There is some œdema, attributable either to obstruction of the lymphatics or to the impeded flow of the lymph.

In 31 out of 55 recorded cases, a discharge of lymph (**Lymphorrhœa**) has been observed. This has also been seen to occur without varix, as the result of wound. In the latter case, the flow is continuous while in the lymphorrhœa which attends varix, it is to some extent intermittent. The identity of the fluid discharged with lymph has been established by chemical and microscopic examination. An excessive discharge of the fluid is liable to produce symptoms of general debility, of the same kind as those induced by hæmorrhage.

Treatment.—Spontaneous cure of lymphatic varix has been observed in cases where the penis was affected, the disease being the result of the obstruction to the flow of lymph caused by buboes. In other instances, various plans of treatment have been tried, with apparently indifferent result. Caustics have been used by several Surgeons, but, as the disease is often deeply seated as well as superficial, with but little result. Beau treated three cases successfully by introducing a seton into the dilated lymphatic vessels, and exciting adhesive inflammation. B. Bell advises ligature of the lymphatic vessel from which the discharge of fluid takes place. Compression by means of a bandage has been recommended by Nélaton.

Besides the diseases of the lymphatics and those glands here described, other pathological conditions have been observed. Thus, the

Cancer in other situations

glands may undergo *cancerous degeneration* as the result of absorption from a primary cancer ; and in other cases they have been found to have undergone *calcification* as the result of tuberculous degeneration, or chronic inflammation.

CHAPTER XL.

DISEASES OF VEINS.

PHLEBITIS.

Inflammation of the Veins, originally studied by Hunter, has in later years attracted the attention of many distinguished Continental and British pathologists, amongst whom may be especially mentioned Breschet. Velpeau, Cruveilhier, Arnott, Henry Lee, and Tessier.

Phlebitis is of two kinds, *Idiopathic* and *Traumatic*. **Idiopathic phlebitis** will occur, independently of any external exciting cause, or perhaps from exposure to wet and cold, in one of the large veins, almost invariably those of the lower extremity—the saphena, popliteal, femoral, or iliac. It most usually assumes the *adhesive* form ; and is most commonly met with in persons of gouty constitution.

Traumatic phlebitis is commonly *excited* by the wound of veins, as in operations, venesection, and injuries of various kinds ; or it may result from their contusion, or the application of ligatures to them ; and it is especially *predisposed* to by a previously unhealthy condition of the blood, by epidemic constitution, and by season—in fact, by those influences that dispose generally to the low and diffused forms of inflammation. It is sometimes adhesive, but not unfrequently diffuse, and is highly dangerous, being often the forerunner and the exciting cause of pyæmia. To this variety of phlebitis may be referred the ordinary phlegmasia dolens and white leg of parturient women.

Pathology.—When a vein is inflamed, important changes occur both in the coats of the vessel and in the contained blood. The coats generally become thicker, the outer one especially being vascular and infiltrated ; the inner coat becomes softened, pulpy, and usually more or less stained of a dark-red or purple hue by the coloring matter of the blood. The blood in the inflamed vessel coagulates, and adheres to its sides ; this tendency to coagulation and adhesion being increased by the effusion of lymph from the wall of the vessel. This plugging of the vein appears to be due to two distinct causes, which may, however, be associated—one being inflammatory, the other embolic.

When a vein has become primarily inflamed, a thin membranous layer of lymph is deposited upon its interior, closely attached to the lining membrane of the vessel ; this thin expansion of exudative lymph attracts the fibrine of the passing blood, which thus tends to become deposited on and to be incorporated with it. The mass grows by a process of aggregation until the whole of the vessel is filled for a distance of one, two, or more inches by this plug of thrombus—partly composed of exudative material, partly of coagulated blood.

But there is another form of the disease, the *Embolic*, in which the vein becomes plugged in a different manner In these cases, blood charged with minute granular embola, the result, possibly, of the disinte-

gration of arterial thrombi (p. 703), circulates through the body, and, passing through the capillaries, arrives at last at some position in the venous system where, favored by anatomical arrangement, previous disease of the coats of the vessel, or accidental constriction from position of a limb or part, the embolon separates itself from the circulating blood and becomes deposited on the inner surface of the vein, where it, in its turn, forms the nucleus of a thrombus, by which the vessel is speedily plugged. This thrombus may become broken up and disintegrated. Embola may become detached from it, and, passing up to the right ventricle, may be driven into the pulmonary artery by the cardiac contractions, and, according as they obstruct its larger or its smaller divisions, may be the cause of sudden death or of some of those forms of intrapulmonic hæmorrhage that usually go by the name of "pulmonary apoplexy." Thus embola formed in and starting from the left cavities of the heart, becoming disintegrated, may pass through the capillaries into the veins, there to be deposited, forming thrombi which, in their turn breaking up, yield fresh embola that may be productive of fatal plugging of the pulmonary artery, the plug making the whole of the circuit of the vascular system before it becomes destructive to life. These changes may occur in any vein, external or internal, and we often find them associated—the same vessel containing a mixture of coagulum and fibrine. The extent of surface which the inflammation may occupy varies from that of a small vessel a few inches in length, to the trunk and branches of one of the largest veins in the body. The obstruction of the vein, which is the common result of these forms of the disease, may continue permanently; the plug becoming incorporated with its coats, and gradually undergoing fibro-cellular degeneration, so that the vein is converted into an impervious cord. In other cases, a channel eventually forms through the axis of this obstructing clot, allowing the circulation through the vein to be re-established in a more or less imperfect manner.

If the thrombosis and resulting embolism be of a septic character, pyæmia and multiple abscesses, as has been fully described in Chapter XXXIII., will result. The difference between the plastic and the septic embolon is this, that the first leads to fibrinous deposits in the veins and internal organs, the effects of which are purely local, the other to disintegration of blood-clot, to metastatic abscesses, and pyæmia.

Symptoms.—In phlebitis, the action is usually localised, and limited. Commonly the disease is idiopathic, but it may arise from traumatic causes, and not unfrequently is subacute. When traumatic, it may occur in any vein that is wounded; but, when idiopathic, it commonly occurs in those situated in the calf or leg, especially if they be varicose. The inflamed vein becomes hard, swollen, knobbed, and painful, the knobs constituting distinct enlargements opposite to the valves; if superficial, it presents a reddish-purple color; and there is some degree of pain, stiffness, or inability to move the limb. There may perhaps be no pain when the limb is at rest, but in some cases there are very severe shocks of pain, resembling neuralgia, darting through the limb; and in all cases there is deep tenderness over the course of the vessel. There is always some œdema around the inflamed vein, and in the part that supplies it with blood. This œdematous condition of the limb is a most important diagnostic sign in deep-seated embolic phlebitis when the vein cannot be felt (as in the pelvis, for instance), and may perhaps be the first symptom observed, coming on either suddenly or gradually. The œdema may give rise to a hard, white, and tense condition of the limb, which pits on pressure, though in some cases the hardness is too great for this.

Occasionally, in deep phlebitis the limb may suddenly swell to a considerable size without there being any subcutaneous œdema. In phlebitis of the deep veins of the leg and thigh, the calf of the affected limb may suddenly enlarge, with great pain and much distension of the superficial veins with fluid blood, but without any subcutaneous œdema. As the inflammation subsides, the swelling of the limb goes down, the circulation passing through its former channels, or the blood being carried off by the collateral venous system. If suppuration occur, no change takes place in the symptoms so long as the pus is localised or encysted. It may perforate the coats of the vein, and, passing into the external areolar tissue, form a common abscess. If it break through its plastic barriers within the vein, then a very different result occurs, and the symptoms of pyæmia come on. But, unless this occur, the constitutional disturbance in this form of phlebitis is very mild.

Treatment.—The first point to be attended to in the treatment of obstructive phlebitis is absolute rest of the limb affected. The importance of rest in these cases is twofold: 1st, to prevent pain and increase of local mischief; and, 2ndly, to guard against the danger that may result from the detachment of a thrombus, which, carried into the current of the circulation, may occasion sudden death by plugging of the pulmonary artery, or more remotely fatal consequences by embolic disintegration and deposit in the lungs or brain. Much local comfort is derived from hot fomentations. The constitutional treatment must be conducted on ordinary medical principles, in accordance with the age and strength of the patient. As a rule, depletory measures are not well borne, and early recourse must be had to a tonic or stimulating plan. The hardness which is often left after the removal of the inflammation may usually be removed by salt and nitre poultices, as recommended by Basham. If abscesses form, they must be opened. If œdema of the limb continue, the application of blisters, or the pressure of an elastic roller, will remove it. But the limb rarely, if ever, completely recovers its natural size.

Diffuse Phlebitis has been described as an erysipelatous form of the disease, often running for a considerable distance along the lining membrane of the vein, which becomes thickened, pulpy, and red, without adhesions forming or the blood coagulating; indeed, in cases of this kind there appears to be a great want of plasticity in that fluid. This form of phlebitis is commonly, though not always, fatal; its fatality was supposed by Hunter to be owing to the extension of the inflammation to the heart, and by Hodgson to the extent of surface affected; but Arnott has shown that the inflammation scarcely ever reaches the heart, and that the extent of vein inflamed is commonly very limited—it not unfrequently happening that the disease proves fatal when but a few inches are affected, as in the vessels of a stump. But a more modern pathology has shown that death in these cases is invariably due to pyæmia.

Symptoms.—The diffuse phlebitis is ushered in by the ordinary symptoms of pyrexia, at the same time that pain and tenderness, with a certain amount of œdema and hardness, may manifest themselves along the course of the inflamed vessel. These symptoms, however, speedily give way to those that characterise the lowest forms of ataxic fever—such as a fluttering pulse, a brown tongue, sordes about the mouth and teeth, with much anxiety of countenance, diarrhœa, vomiting, extreme prostration, delirium, and death. The symptoms are, indeed, due to the formation of pus in the vein, its admixture with the blood, and consequent poisoning of the system. The whole danger and peculiarity of diffuse

phlebitis depend, I believe, upon this circumstance; and I would, therefore, refer for the consequence and treatment of this form of the affection to the chapter on Pyæmia (p. 692). In phlebitis there are two great sources of danger, viz., that of embolism leading to sudden death by the plugging of the pulmonary artery in the adhesive, and of pyæmia in the diffuse form of the disease.

The *Treatment* of this form of phlebitis resolves itself into that of its secondary and important constitutional condition—the pyæmia to which it gives rise (p. 710).

VARIX.

By **Varix**, or **Varicose Veins**, is meant a dilated condition of these vessels, with hypertrophy of their coats, giving rise to œdema, tension, weight, and pain in the parts they supply—often with a good deal of numbness, difficulty in motion, or loss of power in the affected limb. In other cases, their pressure on the nerves of the part (as when the veins of the spermatic cord are enlarged) may give rise to very severe suffering.

Appearance.—Varicose veins are tortuous, dilated, and sacculated; they are serpentine in their course, and feel thick under the finger. They may be superficial or deep-seated; when superficial, the disease is often limited to one of the larger venous trunks of a limb, the smaller branches not being engaged. This we commonly see to be the case in the internal saphena; in other cases, the small cutaneous veins alone may be affected, appearing as a close network of a purplish-blue color under the skin, with much discoloration of parts, and some œdema of the limb; or both sets of vessels may be implicated. The deep-seated varix is not by any means so common as the superficial; and, when it occurs, is generally the result of the pressure of a tumor, or of some similar cause. Varicose veins, especially when superficial, are very apt to inflame, with coagulation of the blood within their sinuses.

Locality.—The veins of the skin and the mucous membranes are those that are most liable to varix. It is most commonly met with in the legs, and more particularly in the trunk of the internal saphena; but any of the superficial veins, as of the arms, chest, head, neck, hypogastrium, or thorax, may be affected. The veins about the anus are especially liable to varix, constituting some forms of hæmorrhoids; the spermatic veins, also, very often become enlarged, constituting varicocele. As a general rule, superficial varix is infinitely more common in the lower than in the upper part of the body, owing evidently to the tendency to the gravitation of blood in the more dependent situations. When occurring at any point above the pelvis, it may be looked upon as arising, in all probability, from the pressure of a tumor of some kind upon the large venous trunks. The deep-seated veins that are principally affected are, the internal jugulars, the vena azygos, and the veins of the prostate.

Causes.—The causes of varix are generally *such conditions as induce more or less permanent distension of the veins.* Thus, for instance, strains, and habitual over-exertion of a part, by driving the blood into the subcutaneous veins, may give rise to their distension; so, also, certain occupations may favor gravitation of blood to the lower part of the body; again, the length of a vein, as of the internal saphena, may occasion its dilatation by the weight of the long column of the contained blood. Any obstacle to the return of the blood from a vein (as the

pressure of a tight garter below the knee, or of a tumor upon one of the large venous trunks) may give rise to its permanent distension, as well as to that of all its branches. In other cases the affection, or the disposition to it, appears to be *hereditary;* and in many instances it is difficult to recognise any cause except an *enfeebled and relaxed state of the walls* of the vessel, such as is met with in tall, debilitated, and phlegmatic people. *Age* influences materially the occurrence of the disease, which, rare in the earlier periods of life, gradually increases in frequency as the individual advances in years up to the middle period of life when the tendency ceases. In *women*, especially, the affection is common; in consequence, partly, of natural debility, but more frequently from the pressure of the enlarged uterus during pregnancy.

Structure.—Varicose veins are sometimes simply dilated, without any thickening; but in other instances they are truly hypertrophied, their cavities being dilated and their walls thickened—the vessel likewise being elongated, forming curves, and bending back on itself. Sometimes the enlargements at particular points appear to be multilocular, the vein forming a series of curves and dilatations together. The valves are always insufficient in varicose veins, being usually bent backwards or ruptured; and the lining membrane is marked by longitudinal striæ. The blood in these vessels has a tendency to coagulate in large masses, the vein being at times the seat of inflammation, by which this tendency is materially assisted. The neighboring and subjacent parts are much modified in structure; and there is usually chronic œdema, with infiltration of the skin and areolar tissue, which may at last run into ulceration—giving rise to the varicose ulcer, which has already been described (p. 189), and which, if communicating with a large branch, may yield a copious or even fatal hæmorrhage. The blood contained in the varicose knots and veins becomes more or less stagnant, and probably altered in its qualities, so as to render the vessels peculiarly liable to inflammation, and possibly even to injure the general health to a remarkable degree.

Progress.—Varicose veins never undergo spontaneous cure: when once formed, the condition is permanent, unless the vessel become plugged by coagulum, when, it being obstructed, the current of blood is diverted into other channels, which in their turn become varicose. The main evil that results from varicose veins in the legs, is the change that is slowly induced in the nutrition of the skin and subcutaneous areolar tissue by the retardation of the circulation, and the interference with the due return of blood. It is in consequence of the imperfect nutrition of the parts that ulceration of the skin takes place, especially where it is naturally thin, as about the ankles. But there is another condition that may occur as the result of varicose veins of the legs, viz., that the varix may give way, the vein may "burst" as is generally said. In these cases the word "burst" is scarcely correct. The varix does not give way by pressure from within; but a process of ulceration goes on from without by which its coats become weakened, so that at last, it being unable to support the column of contained blood, a pin-hole aperture forms, which, rapidly enlarging, leads to the profuse hæmorrhage. This so-called "bursting" of a varicose vein is never so sudden that a Surgeon may not foresee the probability of its occurrence. It may take place on the surface of an ulcer, or it may be preceded by induration, reddening, and thinning of the integuments covering the diseased vein.

Treatment.—This must be conducted on two principles—to palliate and to cure. The **Palliative Treatment** consists in moderate compression exercised upon the vessel, so as to support its weakened and

dilated coats, and thus prevent its further distension and the pain occasioned by this, as well as the other consequences—such as œdema, disorganisation, and ulceration. The pressure must be applied very smoothly and evenly, lest it irritate and ulcerate the skin, or produce distension of the vein below the part compressed. For the purpose of compression, bandages and elastic stockings are commonly employed. In some cases, elastic pressure by means of a vulcanised India-rubber band or garter may be applied around the limb, so as to simulate the action of the valves of the vein; by compression it cuts off the weight of the column of blood from the terminal branches. In other cases, the application of a truss to the upper part of the saphena vein, as recommended by Colles, may be of service.

If a varix of the veins of the leg bursts, violent bleeding may suddenly take place so as to induce faintness, and even death. The copiousness of the bleeding may be accounted for by its occurring from the *cardiac* side of the varix, the insufficiency of the valves not presenting the ordinary obstacle to the downward flow of blood. The treatment consists in laying the patient flat on the floor and raising his leg, when the hæmorrhage will cease. It may be permanently arrested by the pressure of a compress and bandage.

In certain circumstances, it becomes necessary to change the palliative for a **Curative** plan. This is especially requisite in the following three conditions: 1, if the varix be so large as to produce much inconvenience, or to give rise to severe pain by its pressure on the nerves in its neighborhood; 2, if a varicose vein have burst, or be on the point of giving way; or, 3, if an ulcer dependent on its existence will not heal. Various plans of curative treatment have been recommended; all of which have for their object the obliteration of the vein at one point by exciting adhesive inflammation there, and thus causing it eventually to degenerate into a fibro-cellular cord. In this way the trunk of a varicose vein and the larger masses of varix may be occluded. But can the disease be cured by the local obliteration of the vein? To this question, I have no hesitation in answering in the negative. Though the trunk be obliterated, a collateral venous circulation is set up, which is very apt in the course of a few months to take on a varicose condition, and thus to cause a return of the disease. But, though the cure be not radical, much benefit may often be effected by removing varicose knots that occasion pain or inconvenience, by enabling an ulcer to cicatrise, or by occluding a vein from which hæmorrhage has occurred. The principle of all curative treatment in varix consists in exciting adhesive and localised inflammation in the vein so as to occlude it, and thus, by directing the blood into other channels, to relieve the distension of the diseased vessels and the inconvenient results that follow this. As the treatment thus necessarily involves the artificial excitation of phlebitis, there is always some little risk of the inflammation passing beyond the adhesive stage into that of suppuration, or diffuse inflammation.

Various plans for obliterating the veins have been recommended. They resolve themselves into five principal heads of treatment.

1. The *subcutaneous section* of the vein, or the *excision* of an inch or so of the vessel. This plan of treatment is severe and not unattended by danger, as we learn from Brodie.

2. It has been recommended by Mayo, Seutin, Bonnet, and others, to *excite inflammation in the vein* by producing a series of deep eschars or issues in the skin covering it, by the application of a caustic, such as the chloride of zinc or potassa fusa. Skey speaks very favorably of this

mode of obliterating varicose veins as being devoid of danger. He recommends the eschars to be made by the application of a powder, composed of three parts of lime and two of potash, made into a paste with spirits of wine at the time of application. The eschars should not be larger than a split pea, and their number must depend on the extent of the disease.

3. Others recommend the obliteration of the vessel by *introducing needles into it*, and *transmitting a galvanic current* along and across them. Of this plan of treatment I have not had any experience; nor do I believe that it is ever employed by Surgeons in this country.

4. *Injection of the varix by a few drops of a solution of the perchloride of iron*, as recommended by Pravaz, is a very effectual method of procuring coagulation of the contained blood and consolidation of the varix, more particularly if it be very large and cellular. In employing this means, it is better to compress the vein by means of the finger or a pad and bandage above the varix; the solution is then to be injected in very small quantity—not more than three or four drops—by means of the syringe (which will be described in speaking of the treatment of nævus), into the dilated veins. Coagulation of the blood immediately takes place. The patient must be confined to his bed for a few days with the limb raised, and a bandage should be applied before he is allowed to walk about. This means is very effectual in large varix, and may in such cases be advantageously conjoined with the next method—the pins being used under the venous trunks, and the solution introduced into the dilated masses of the varix. But it is not devoid of danger; accidents, such as local suppuration and sloughing, pyæmic symptoms, and even fatal embolism, have followed its use.

5. The most convenient and safest way of obliterating the vein in my opinion, and that which I always employ, consists in *compressing the vessel at several points*, by passing a hare-lip pin underneath it, laying a piece of wax-bougie over it, and then applying the twisted suture around the pin and over the bougie (Fig. 332*a*). In this way the vessel

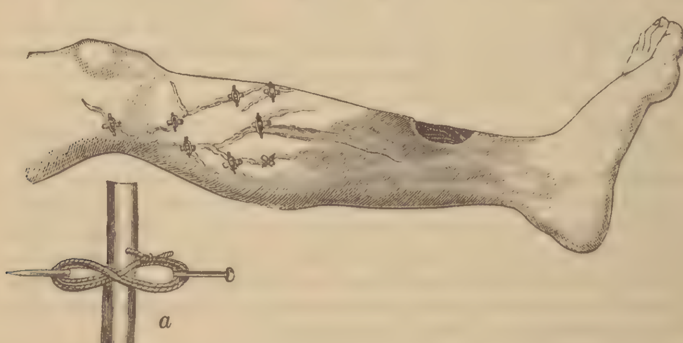


Fig. 332.—Application of Hare-lip Pins to Varicose Veins.

gradually ulcerates by the pressure that is exercised upon it, and the presence of the bougie prevents the ligature from injuring the skin. In performing this operation, care must be taken that the vein be not transfixed, but that the pin be pushed, or rather dipped underneath it; the ligature should not be too thin, and must be applied tightly over the bougie; several pins (as many as eight or ten, if necessary) should be introduced along the course of the same vessel, at distances of about three-

quarters of an inch from one another (Fig. 332); those highest up should be put in first, and they should be left in for at least a week or ten days, by which time the obliteration of the vessel will have taken place. I believe that all the danger of the operation consists in the transfixion of the vein by the pin; the operator may always know when he has done this by the escape of a few drops of venous blood; when the pin is properly passed under and clear of the vein, the operation is a perfectly bloodless one. If the vein be transfixed, the pin should immediately be withdrawn and passed at another point; if it be allowed to remain in the vein, it will act as a foreign body, and suppurative phlebitis may ensue. Where the vein is properly compressed between the pin below and the bougie above, adhesive inflammation takes place in it, and it becomes obliterated at the point of pressure. By attention to these circumstances I have never met with any ill consequences, either from suppurative phlebitis or pyæmia, in any of the cases in which I have performed this operation, which are several hundreds in number.

In addition to the application of the pins in the usual way, H. Lee has recommended the subcutaneous division of that portion of the vein which is included between them, after coagulation of the blood has taken place. This I have found to be an useful addition to the ordinary treatment, and to insure the obliteration of the vessel.

The points of the pins may be prevented from pressing injuriously upon the skin, by putting small pieces of adhesive plaster under them. The powers of the constitution should at the same time be improved, and the activity of the circulation kept up by nourishing diet, tonics, and wine. Whilst the pins are in, the patient must not be allowed to move about, and after they have been taken out, the limb should be bandaged for some time. In general no ulceration takes place about the pinhole apertures; but occasionally, in debilitated constitutions, a sore forms, which requires to be treated on ordinary principles.

CHAPTER XLI.

ANEURISM BY ANASTOMOSIS AND NÆVUS—HÆMORRHAGIC DIATHESIS.

ANEURISM BY ANASTOMOSIS.

Aneurism by Anastomosis is a disease of the arteries, in which the vessels become excessively elongated, tortuous, and serpentine; sometimes they assume a varicose condition, being dilated into small sinuses, and are always very thin-walled, resembling rather veins than arteries in structure. This kind of dilatation of the vessels gives rise to pulsating tumors, often of considerable size, and of a very active and dangerous character. They may be situated in almost any tissue or organ of the body, but are most commonly met with in the submucous and subcutaneous areolar tissue, and most frequently occur in the upper part of the body, especially about the scalp, orbit, lips, and face; but they have been met with in other situations, such as the tongue, and even in internal organs, as the liver; and I have seen very active growths of this kind on the side of the chest, nates, and foot. In some cases, aneurism by anastomosis occurs in bones, in which it forms a special

disease, and is not uncommonly associated with some form of malignant growth. It will generally be found that the arteries leading to the aneurism by anastomosis, though at a considerable distance from it, are tortuous and enlarged, with thin and expanded coats, and pulsate actively; in fact, constituting that condition that goes by the name of **Cirsoid Dilatation** of the vessels.

Aneurism by anastomosis forms tumors of varying magnitude and irregular shape; they are usually of a bluish color, have a spongy feel, are readily compressible, not circumscribed, and have large tortuous vessels running into and from them on different sides. Their temperature is generally above that of neighboring parts; and a vibratory or purring thrill, amounting in many cases to distinct pulsation, may be felt in them. This pulsation or thrill is synchronous with the heart's beat, may be arrested by compressing the tumor or the arteries leading to it, and returns with an expansive beat on the removal of the pressure. The bruit is often loud and harsh, but at other times of a soft and blowing character. These growths rarely occur in infancy, but generally make their appearance in young adults, though they may be met with at all periods of life, often as the consequence of injury.

Diagnosis.—It is of importance to effect the diagnosis between *ordinary aneurism* and that by anastomosis. In many cases the situation of the tumor at a distance from any large trunk, as on the scalp, the outside of the thigh, or the gluteal region, will determine this. Again, the outline of the growth is less distinct than in true aneurism; and tortuous vessels will be felt leading to it from different directions. The swelling also is doughy and very compressible; but when the pressure is removed, the blood enters it with a whiz and thrill, not with the distinct pulsating stroke that is found in aneurism. The pulsation, not so forcible as in aneurism, is more heaving and expansive. The bruit is louder, and more superficial, sometimes having a cooing note. By pressure on the arteries leading to the tumor those signs are usually not entirely arrested, though diminished in force, the blood entering it from the neighboring parts, and in a less direct way.

Treatment.—The treatment of aneurism by anastomosis must depend upon the size and situation of the growth. When it is so placed that it can be *ligatured* or *excised*, as on the lip, or when small, about the neck, face, or scalp, trunk, or extremities, it should be removed. I always prefer the ligature, applied as will immediately be described, as being the safest, and upon the whole the readiest mode of removing such a tumor. If excision be practised, it is necessary to be very careful to cut widely of the disease; if it be cut into, fearful hæmorrhage may ensue, which can only be arrested by pressure, and which in several instances has proved fatal.

If the disease be very large and extended, as is commonly seen on the scalp, or if deeply seated, as in the orbit, neither ligature nor excision of the tumor can be practised, and it becomes necessary to starve it by cutting off its supply of blood. This may be done either by *ligaturing the principal branches leading to it*, or *the main trunk* of the limb or part.

Simple ligature of the *arterial branches leading to the tumor* has never, I believe, been followed by success; at least, in ten recorded instances in which it has been had recourse to, the disease has not in one instance been cured. It has, however, been successfully conjoined by Gibson, in two cases of aneurism by anastomosis of the scalp, with incisions made round the tumor at intervals between the principal feeding arteries, which at the same time were tied.

The *main trunk* leading to the tumor has been ligatured in a considerable number of cases. The brachial and femoral arteries have been tied for disease of this kind situated on the extremities, and in some instances with success; but the carotid is the vessel that has been most frequently deligated, in consequence of the tumor being commonly situated on the scalp and in the orbit. This operation has been done in twenty-three recorded cases, and in five instances both the carotids were ligatured at intervals of several weeks. In all of those cases in which the double operation was performed, the patients ultimately recovered. In some of the cases in which one carotid alone was tied, the disease, being seated upon the scalp, was not cured; and it was afterwards found necessary to have recourse to ligature of the tumor, to excision, and to other means of removal; indeed, when seated upon the scalp, this disease appears to be more intractable than in any other part of the body, owing probably to the freedom of the arterial supply from the numerous vessels that ramify in this region. Here, however, much benefit might be derived after the ligature of the carotid, by adopting the plan suggested by Gibson of tying the feeding arteries, and making incisions between them down to the bone. The ligature of the carotid has answered best for diseases of this kind in the orbit; of thirteen instances in which the artery has been tied for aneurism by anastomosis in this situation, a cure was accomplished in the majority.

NÆVUS.

This disease, under which are included those various affections termed *Mother's Marks*, *Erectile Tumors*, and *Vascular Growths*, constitutes an important and interesting section of surgical affections. It appears to consist essentially in an excessive development of the vascular tissue of a part, and differs greatly as to nature, cause and treatment; according as the arterial, the capillary or the venous elements of the tissue predominate. The predominance of the arterial tissue we have already considered, under the head of Aneurism by Anastomosis; it now remains for us to describe the Capillary and Venous Nævi. (See also Angioma, p. 739.) Nævi may, and commonly do, occur in the healthiest and best-formed children. But they are more apt to occur in those who are the subjects of other congenital malformations.

Capillary Nævi appear as slightly elevated but flat spots on the skin of a bright red or purplish tint, and having occasionally granular or papillated elevations, with some larger vessels ramifying on their surface. They often spread superficially to a considerable extent; they are usually situated on the face, head, neck, or arms, but occasionally, though more rarely, on the back, the nates, the organs of generation, and the lower extremities. They are, I believe, always congenital, though often at birth very small, not larger than a pin's head, from which they may spread in the course of a few weeks or months to patches an inch or two in diameter. In many cases no inconvenience results from this disease, except the deformity it entails; but occasionally, more especially when the growth is at all prominent, there is a great disposition to unhealthy ulceration. When bleeding occurs from a wound of the nævoid structure it is usually in a trickling stream, and without any degree of force.

Venous or Cavernous Nævi are of a dark purple or reddish color, usually very prominent, and often forming distinct tumors of considerable size, which may either be smooth and ovoid, or else somewhat lobu-

lated. On compressing a growth of this kind, it subsides to a certain extent, feeling doughy, soft, and inelastic; and on the removal of pressure fills again. In some cases, when consolidated by inflammation, or containing cysts, it cannot be lessened in bulk by pressure. These nævi are usually of about the size of half a walnut, but sometimes much larger. I have removed from the nates and the back some quite as large as oranges. They less frequently occur upon the head and face than the capillary form of the disease; most of the instances that I have seen have been met with in the lower part of the body, about the nates, back, lower extremities, and organs of generation.

Subcutaneous nævi are occasionally of a *mixed character*, forming soft, doughy and compressible tumors, capable of diminution by pressure, on the removal of which they slowly fill out again to as large a size as before; they also become distended when the child screams or struggles, and are usually oval, smooth, and uniform. The skin covering the tumor is often unaffected; at other times it is implicated in an oval patch on the most prominent part of the growth, and occasionally the surrounding veins are bluish and enlarged.

Structure.—Capillary nævi appear to be composed of a congeries of small tortuous capillary vessels; venous nævi appear made up of thin tortuous veins, dilated into sinuses and small pouches. In the midst of these masses, cysts are not uncommonly found, sometimes containing clear, at other times dark, sanguinolent fluid. These cysts are probably venous sinuses, the openings into which have become occluded. (See also p. 739.)

Prognosis.—The natural history of nævi has yet to be learnt—we have yet to ascertain what becomes of them when left to themselves. They are so commonly removed by operation, that hitherto Surgeons have had but few opportunities of determining this. I have, however, seen several cases in which from various circumstances no operation had been performed, and I have been struck with the tendency that there is in the cutaneous nævus to disappear. If left untouched, or subjected to continuous pressure, islands or patches of white skin will gradually appear in the reddened surface. These will slowly increase and coalesce, and then the nævus, becoming gradually less vascular, may in time disappear. Subcutaneous venous nævi will sometimes gradually shrink, but the active erectile nævus is progressive.

There is usually a fear expressed of nævi, if left without surgical interference, leading to dangerous or even fatal hæmorrhage. This I have never seen; indeed, if the nævus ulcerates its tissue hardens, and the vessels become blocked up by coagulum and plastic deposit.

Treatment.—In the treatment of nævus, the first point to be determined is whether the case should be left to nature, or whether operative measures should be had recourse to. In deciding this point we must be guided by the size, situation, and character of the morbid growth. If this be small, cutaneous, and superficial, so situated that it occasions little or no disfigurement, and if it show no tendency to increase, it may be left without interference; when, as just stated, it may eventually shrivel and disappear, or become converted into a kind of mole. In some cases this process may be hastened by the application of tincture of iodine or liquor plumbi. In other cases, again, the nævus, though cutaneous and superficial, is so widely diffused over the surface, that no attempt at its removal or destruction can be entertained with prudence. But, if the nævus be large, if it be subcutaneous, or if it increase in

size, or if it be so situated as to occasion disfigurement, means must then be adopted for its removal by operative procedure.

Operations for the removal of nævi may be conducted on five principles:—1, to excite adhesive inflammation in them, and so to produce plugging and obliteration of the vascular tissue of which they are composed; 2, to destroy the growth by caustics; 3, to remove it by the galvanic cautery; 4, to remove it with the knife; or, 5, to remove it by ligature. Each of these different plans of treatment is peculiarly applicable when the disease assumes certain forms, and affects certain situations.

1. When the nævus is of small size, and occurs in such situations that its destruction by caustics, or removal by knife or ligature, would be attended by serious deformity, as when it is seated about the eyelids, upon the tip of the nose, at the inner angle between the eye and the nose, or about the corners of the mouth, it is best *to endeavor to procure obliteration, by exciting adhesive inflammation in it.* This may be done in various ways. If small, the nævus may be vaccinated. If it be larger, the most convenient plan consists, perhaps, in passing a number of fine silk threads across the tumor in different directions, and leaving them in for a week or two at a time, until they have produced sufficient inflammation along their tracks, then withdrawing them and passing them into other parts of the tumor. In this way its consolidation may gradually be effected. Another very useful plan is to break up the substance of the growth subcutaneously by means of a cataract-needle, or tenotome, and, in the intervals between the different introductions of this instrument, to keep up pressure upon the tumor. In other cases, again, the requisite amount of consolidation will be induced by passing acupuncture-needles into the nævus, and then heating them by means of a spirit-lamp. Perhaps the most efficient way of obtaining this object is by injecting the perchloride of iron by means of a small glass syringe with a screw-piston rod and a fine sharply pointed platinum nozzle (Fig. 333). In doing this, care must be taken that but a very small quantity of the solution, not more than two or three drops, be injected at one time. The perchloride of iron possesses extraordinary power of coagulating the blood; and, if more than has just been mentioned be thrown in, the tissue of the nævus may either have its vitality destroyed, and slough, or coagulation of the blood in the vessels beyond the nævus may occur, and a dangerous or even fatal embolism ensue from the coagulum thus formed being washed into the current of the circulation.

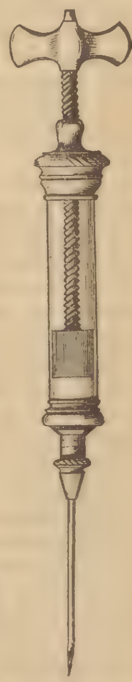


Fig. 333.—Syringe for Injecting Nævus.

2. When the nævus is small, very superficial, of the capillary character, with an exceedingly thin cover of cuticle, and so situated, as upon the arm, neck, or back, that a moderate amount of scarring is of little consequence, it may most conveniently be removed by the *free application of nitric acid.* This should be well rubbed on by means of a piece of stick; and, after the separation of the slough, its application must be repeated as often as there is any appearance of the granulations springing up, which occasionally happens at one angle of the wound, and indicates a recurrence of the vascular growth.

3. The *galvanic cautery* has been used in a large number of cases by continental Surgeons, especially Middeldorpf of Breslau. In 130 cases tabulated by Mass of Breslau, this treatment was completely successful in 112. Eleven were improved; 3 died; and the result in 4 was unknown. Of the 130 cases, 34 were capillary nævi, and of these 32 were cured: and 83 were venous nævi, of which 72 were cured, 3 died, and 8 were improved. There are two methods by which nævi may be cured by the electric cautery: viz., by electrolytic action, the nævoid structure being gradually consolidated and thus removed; and secondly, by the cauterising action of a platinum wire made red-hot.

Superficial nævi may readily be destroyed by means of the Galvanic Cautery, or by Paquelin's Thermic Cautery. But this method of treatment is not applicable to nævi situated in deep cavities, or amongst important structures. In such cases the galvano-puncture may be employed with the view of decomposing by electrolytic action the contained blood, and thus causing the obliteration of the nævus by coagulation. The details of this method are identical with those of galvano-puncture in the treatment of aneurism, and will be found fully described in Vol. II.

4. When the nævus is large, constituting a more or less distinct tumor, and is of a somewhat venous character, it may occasionally be *excised.* Teale, junior, has shown that some nævi which are distinctly encapsuled may readily be dissected, or rather shelled out. Should the nævus, however, be diffused, without any distinct limiting capsule, care should be taken to cut wide of the disease; and no operation with the knife should be undertaken unless the growth be either so situated, as upon the lip, that the parts may readily be brought or compressed together, or upon the nates or thigh, where it is unconnected with large blood-vessels, and is also very indolent and venous. If the nævus be arterial, or partake of the nature of aneurism by anastomosis, it should not be touched with the knife. It is especially when the nævus is lipomatous or cystoid, or is distinctly encapsuled, that excision may be advantageously practised.

5. As a general rule, it is far safer and more convenient to extirpate the growth with the *ligature;* and this, indeed, is the mode of treatment that is most generally applicable to tumors of this kind in whatever situations they may occur, as it effectually removes them without risk of hæmorrhage, and leaves a sore that very readily cicatrises.

The ligature requires to be applied in different ways, according to the size and situation of the tumor. In all cases, the best material is firm, round, compressed whip-cord. This should be tied as tightly as possible, and knotted securely, so that there may be no chance of any part of the tumor escaping complete and immediate strangulation. It is well, if possible, not to include in the noose any healthy skin, but to snip across with a pair of scissors that portion of integument which intervenes between the cords that are tied together; at the same time, care must be taken to pass the ligatures well beyond the limits of the disease.

When the tumor is small, an ordinary double ligature may be passed across its base, by means of a common suture-needle; and, the noose being cut and the thread tied on each side, strangulation will be effected.

When it is of larger size, and of round shape, the most convenient plan of strangulating the tumor is that recommended by Liston. It consists in passing, by means of long nævus-needles, fixed in wooden handles, and having the eye near their points, double whip-cord ligatures in opposite directions across the tumor; then cutting through the nooses, and

tying together the contiguous ends of the ligatures until the whole of the growth is encircled and strangled by them. In doing this, a few precautions are necessary: thus, the first nævus-needle should be passed across the tumor unarmed (Fig. 334), and used to raise up the growth

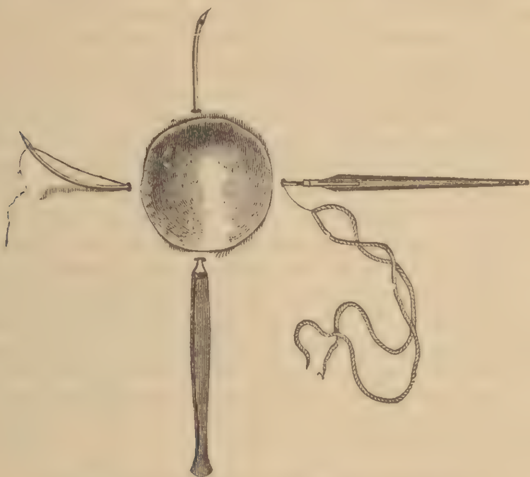


Fig. 334.—Diagram of the Application of Nævus-needles.

somewhat from the subjacent parts. The second needle, armed as represented in the diagram (Fig. 334), carrying the whip-cord ligature by means of a piece of suture-silk, should be passed across the tumor in the opposite direction to, but underneath, the first needle; the armed needle being withdrawn, the ligature is carried across; and the first one, having been armed in the same way, carries its noose through the tumor as it is drawn out. The two nooses having then been cut, an assistant must seize, but not draw upon, six of the ligature ends; the Surgeon, then, having divided the intervening bridge of skin, ties rather tightly, in a reef-knot, the two ends that are left hanging out; as soon as he has done this, he proceeds to the next two, and so on to the last (Fig. 335). When he ties these, he must do so with all his force, especially if the tumor be large, as by drawing on them he tightens all the other nooses, and drags the knots towards the centre of the growth, which is thus effectually strangled. He then cuts off the tails of the ligature. After the tumor has sloughed away, which happens in a few days, if it be properly and tightly strangled, the wound is treated on ordinary principles. If the nævus be altogether subcutaneous, the skin covering it should not be sacrificed, but, being divided by a crucial incision, may be turned down in four flaps, and the ligature then tied as directed.

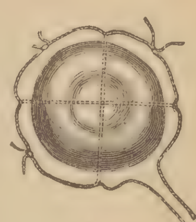
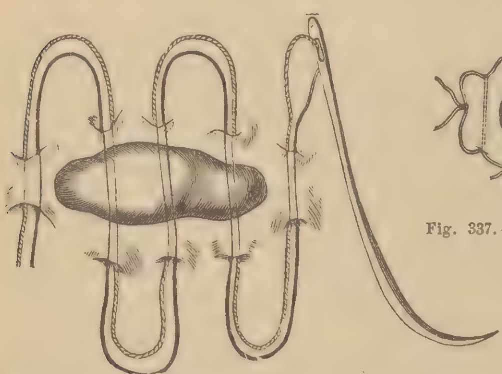


Fig. 335.—Diagram of Nævus tied.

In some cases, the nævus is so flat and elongated that the application of the quadruple ligature, as above described, cannot include the whole of it. In these circumstances, I have found the ligature about to be described eminently useful, having successfully employed it in a great number of instances. Its great advantage is that, while it completely and very readily strangles the tumor, it does not inclose an undue quantity of integument, and thus does not produce

a larger cicatrix than is necessary for the eradication of the disease. It is applied in the following way. A long triangular needle is threaded on the middle of a whip-cord about three yards in length; one-half of this is stained black with ink, the other half is left uncolored. The needle is inserted through a fold of the sound skin, about a quarter of an inch from one end of the tumor, and transversely to the axis of the same. It is then carried through, until a double tail, at least six inches in length, is left hanging from the point at which it entered; it is next carried across the base of the tumor, entering and passing out beyond its lateral limits, so as to leave a series of double loops about nine inches in length on each side (Fig. 335). Every one of these loops should be made about three-quarters of an inch apart, including that space of the tumor; and the last loop should be brought out through a fold of healthy integument beyond the tumor. In this way we have a series of double loops, one *white*, and the other *black*, on each side (Fig. 336). All the *white* loops should be cut on one side, and the *black* loops on the other, leaving hanging ends of thread of corresponding colors. The tumor may now be strangulated by drawing down and knotting firmly each pair of *white* threads on one side, and each pair of *black* ones on the other. In this way the tumor is divided into segments, each of which is strangulated by a noose and a knot: by *black* nooses and *white* knots on one side, by *white* nooses and *black* knots on the other (Fig. 337).



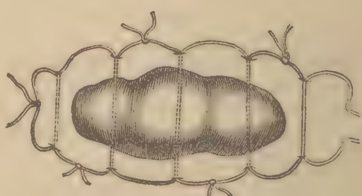


Fig. 337.—Diagram of Flat and Elongated Nævus tied.

Fig. 336.—Diagram of Ligature of Flat and Elongated Nævus.

The cicatrix resulting from the removal of a nævus is usually firm and healthy; but, in some instances, I have seen it degenerate into a hard warty mass requiring subsequent excision. The ligature may be used successfully at all ages. I have repeatedly tied large active nævi in infants a month or two old without meeting with any accident.

Nævi in Special Situations.—**Nævi of the Scalp** are more frequent than in any other situation, except, perhaps, the face. When occurring on those parts that are covered by hair, they are almost invariably prominent and subcutaneous: when seated on the forehead, or on the bare skin behind the ears, they are often cutaneous. The ordinary subcutaneous nævus of the scalp is readily removed by the application of the *quadruple ligature*. Care must be taken in passing the needles not to include the tendon of the occipito-frontalis, or troublesome cellulitis and perhaps suppuration may occur beneath that membrane. In general, it is better not to attempt the preservation of any of the integument covering the growth. It is true that, when removed, a clean white

cicatrix is left which never covers itself with hair; but this contracts, and in after-life becomes but little visible. The attempt to dissect down the skin that covers the nævus is not only troublesome, but is attended by very considerable, and possibly dangerous, hæmorrhage. Those flat nævi that are situated behind the ear are best treated by the free application of fuming nitric acid.

Nævus of the Fontanelle is the most important variety of the scalp-nævus, and constitutes a somewhat formidable disease. A large purple tumor is situated within the anterior fontanelle, rising and falling with the pulsations of the brain communicated to it, and becoming distended and tense when the child cries. The tumor is evidently close upon the membranes of the brain, and may be looked upon almost as an intracranial rather than a scalp-tumor. The close proximity of the tumor to the brain and its membranes often deters practitioners from interfering with it; and I not unfrequently see cases in which the parents of the child have been counselled not to allow any operation to be practised, lest death should result. Yet this tumor, so formidable in appearance, and so deeply seated, close upon the brain, and as it were within the cranium, may be removed with perfect safety by the *ligature*. I have often tied nævi in this situation, and have never seen any ill consequences, not even a convulsive fit, occur. The danger, then, from the mere strangulation of the tumor in this situation cannot be great; but there is another and a special danger, viz., the risk of wounding the membranes of the brain in passing the ligatures under the base of the tumor. If nævus-needles or sharp-pointed instruments of any kind be used, this accident will be very likely to occur; and, if this were to happen, inevitably fatal consequences will ensue. This accident may always be avoided by operating in the following way. A puncture is made in front of the tumor through the healthy scalp. An eyed-probe, armed with a double ligature, is then pushed through this opening across the base of the tumor, and its end is made to project on the opposite side beyond it; here another puncture is made, and the probe and ligature together are drawn through. The same procedure is adopted across the tumor sideways. In this way, a quadruple ligature is passed across the tumor in two opposite directions: the ends are then disengaged, and the ligature is tightened in the ordinary way.

Nævi of the Face are of very common occurrence, and usually cause much disfigurement. The treatment to be adopted necessarily varies greatly, according to the nature of the nævus, whether cutaneous, subcutaneous, or both; and especially according to its situation. The same plan, which is advantageously adopted in one part, may be altogether inapplicable in another. We shall, accordingly, consider the treatment of these vascular growths, as they affect the eyelids, the nose, the cheeks, and the lips.

Nævus of the Eyelids is usually cutaneous, consisting of a discoloration or staining, as it were, of the lid, without any material swelling. Such a disease is, I think, better left untouched; it cannot, of course, be removed either by the knife or by caustics, without producing worse results; and, as the skin is always deeply involved, milder means are inoperative, or possibly equally destructive. I have heard of sloughing of the eyelid being occasioned by the use of astringent injections; though, if the nævus were subcutaneous, and constituted a distinct tumor, passing perhaps into the orbit, injection with the perchloride of iron might advantageously be adopted.

Nævus of the Nose may occur in two situations—at the root, or towards the alæ and apex. When seated at the root of the nose, upon

the bridge, or at the lower part of the forehead, between and perhaps extending above the eyebrows, it is often subcutaneous, and may attain a very considerable magnitude. In cases of this kind, I have found the *quadruple ligature* the readiest means of removal; and although the part included may be of large size, the resulting cicatrix is wonderfully small and narrow, usually becoming horizontal, so as to fall into the folds of skin naturally existing in that situation. In the case of a little girl about three years of age, brought to me some years ago by Gerber, I removed a nævus that was cutaneous as well as subcutaneous, and as large as a walnut, from this situation, by means of the quadruple ligature, with the most satisfactory result, the resulting cicatrix being remarkably small; and in another little girl, from the bridge of whose nose I removed, some years ago, a nævus as large as a marble, very little scarring or deformity resulted. In both these cases, the nævus was cutaneous as well as subcutaneous. If the skin be not affected, injection of perchloride of iron may be advantageously employed in such cases. When the tip and alæ of the nose are affected, the nævus being cutaneous, we can seldom do much to improve the appearance of the patient. In such cases, I have tried breaking down the nævus, and the galvanic cautery, without any material benefit; the destruction of the tissues soon afterwards leading to deformity. When the nævus is subcutaneous, occupying the tip, alæ, and columna nasi, injection with perchloride of iron is the only means that I have found of real service. In doing this, care must be taken not to throw in too much of the liquid, lest sloughing or sudden death result.

Nævi of the Cheeks may occur in three distinct forms. 1. There may be a simple cutaneous nævus, a mere staining of the skin, a "mother's mark." This admits of no treatment; and the subject of it must submit to continue through life to exhibit the characteristic discoloration. 2. The elevated cutaneous nævus may be raised above the surface, being of a deep purplish red or plum color, and covered with a very thin integument. In this form of the disease, I think that the application of concentrated nitric acid is the best means of extirpation. By one or two free applications of the caustic, the growth is removed, and a dense white cicatrix, presenting little disfigurement, is left in its place. 3. The nævus may involve the whole thickness of the cheek, being scarcely, if at all, cutaneous. Nævi of this kind cannot, of course, be extirpated, either by the knife, ligature, or caustics, lest the cheek be perforated, and the most serious disfigurement ensue. In such cases we must endeavor to obliterate the structure of the nævus by exciting inflammation in it by setons, or by breaking down the structure of the growth with cataract-needles or a fine tenotome. In a case which I attended some years ago, with Bartlett of Notting Hill, a large and deeply seated nævus, which occupied one cheek, was cured by having a number of fine silk threads passed across it in different directions, and then being gradually, piece by piece, broken down with a cataract-needle; no disfigurement whatever being left.

Nævi of the Lips require different treatment, according as they occupy the margin or have involved the whole substance of these parts. When seated at the margin, as projecting and somewhat pendulous growths, they may readily be removed by a double or quadruple ligature, according to their size. This was the practice pursued in the case from which the accompanying drawings (Figs. 338, 339) were taken, where a most excellent result was obtained by the use of the ligature, followed at a later period by injection of perchloride of iron into some of the more widely diffused parts of the growth. When the nævus involves

the whole thickness of the lip, such measures are not always available. If it deeply invade the substance of the lip, an operation somewhat similar to that for the removal of a cancroid growth might be practised; the whole substance of the lip being cut through widely on each side, and

Fig. 338.—Nævus of Lower Lip Front View.

Fig. 339.—Nævus of Lower Lip: Side View.

the edges of the incision brought together with hare-lip pins. Such an operation is only practicable when the disease, though deeply seated, does not spread to any very great extent laterally. When it does, the whole of one half of the lip, for instance, being involved, the use of the knife, especially in young infants, would be too hazardous, on account of the probability of serious hæmorrhage; and other means must be employed. I have tried the use of setons, and of injections with perchloride of iron; but not with any advantage. When the whole substance of the lip is involved, inclusion and strangulation of the morbid mass by means of the ligature are seldom available; the amount of sloughing being very great, and the child, absorbing the putrescent matters from the sloughing mass which results, incurring the danger of being poisoned from this source. In an infant with a very large nævus, including one half of the lip, which I ligatured at the Hospital some years ago, death appeared to result from this cause. One of the most formidable cases of nævus of the lip that I have ever had to do with, and in its results the most satisfactory, was sent to me several years ago, by Budd, of Barnstaple. The patient, a little girl five months old, was noticed at birth to have a red streak on the right side of the upper lip; this rapidly developed into a large tumid purple nævus, which, when the case came under my observation, was about the size of a large walnut, involving the whole of the structures of the lip, from the cutaneous to the mucous surfaces; it was of a deep mulberry color, and extended from the median line of the lip to the angle of the mouth (Figs. 340, 341). The integuments covering this growth were exceedingly thin, and the tumor itself was in the highest degree vascular and active. Excision appeared to be out of the question; the ligature presented little to recommend it; injections with the perchloride of iron and the introduction of setons were successively tried, but neither of these means produced any effect on the tumor, which commenced to extend upwards into the nostril. I accordingly determined on using caustics. Nitric acid was first employed; but, as this did not produce sufficiently deep impression on the growth, I had recourse to the potassa cum calce. By means of this, the tumor was gradually removed; the hæmorrhage which occasionally resulted being restrained by pressure. Notwithstanding the amount of tissue destroyed, the resulting cicatrix was small, resembling

that of a badly united hare-lip. Three years afterwards, the child was brought to me again, and I was much struck by the wonderful improvement that had taken place since the removal of the nævus. The lip was smooth, the cicatrix in a great degree worn out, and comparatively little

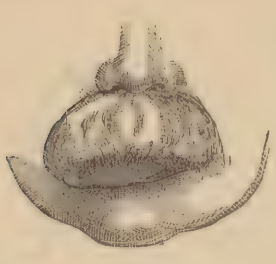


Fig. 340.—Large Nævus of Upper Lip: Front View.

Fig. 341.—Large Nævus of Upper Lip: Side View.

disfigurement was left in the countenance of an exceedingly pretty and engaging child. Finding, however, that the lip was still drawn or tucked in by a very dense band of cicatricial tissue, which caused a deep depression of the ala on that side, I divided this, and the result was most satisfactory.

Nævus of the Tongue is of rare occurrence. I have, however, successfully operated by means of the écraseur in one case, in which the whole of the free extremity of the organ was involved (Fig. 342). The particulars will be found in Chapter LIX.

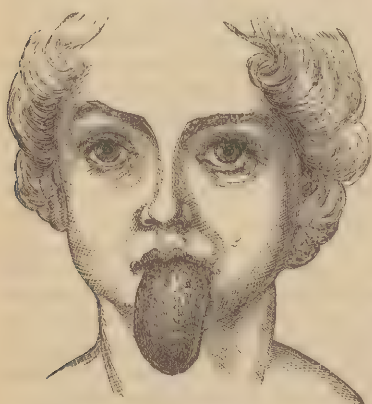


Fig. 342.—Nævus of Tongue.

Nævi of the Organs of Generation are occasionally met with in the female, but rarely in the male. The only instance of *Nævus of the Penis* with which I have met occurred in the case of a gentleman thirty-two years of age, who consulted me some years ago for a growth of this kind, as large as a walnut, situated under the reflexion of the preputial mucous membrane. It had existed for many years without giving any annoyance, but, as it had of late begun to enlarge, and occasionally to bleed, he was desirous of having it removed. This I did by applying the quadruple ligature, after having dissected the mucous membrane down.

Nævi of the Vulva and Pudendum are by no means unfrequent. We have had several instances of the kind in the Hospital of late years. They are usually venous, often attain a large size, and may sometimes involve the integumental structures on the inside of the thigh, or on the perinæum, as well as the vulva. When the growth is confined to the vulva, it is best removed by the ligature. Some time ago, I removed in this way a large pendulous venous nævus, as large as two or three flattened walnuts, from the left labium of a little girl six

years of age. In this case, I found it most convenient to employ the continuous ligature. The same means were had recourse to in order to extirpate a large nævus from the labium of a child three years of age; but in this case the disease extended to the integuments of the perinæum and inner side of the thigh, and was here removed by the application of strong nitric acid, after the larger growth had separated.

On the **Extremities, Neck, and Trunk** every possible variety of nævus occurs. When the disease is flat, consisting rather of staining of the skin than of any actual tumor, it may commonly be treated successfully by the application of the strong tincture of iodine; or should it be thought desirable to remove it, this may be effected by rubbing it with strong nitric acid. If the nævus assume the form of a tumor, it will almost invariably be of a venous character, and then removal by means of the ligature should be effected. If the growth be round, the ordinary quadruple ligature may be employed: if flat or elongated, the longitudinal continuous ligature is preferable.

NÆVOID LIPOMA.—This is a form of nævus with which I have occasionally met, but which does not appear to have attracted much notice, although Nélaton speaks of it, and Billroth says that in lipoma he has several times seen cavernous dilatation of the veins. It is a tumor in which the nævoid structure is conjoined with or deposited in a cellulo-fatty mass. This disease is invariably seated upon the nates, back, or thigh. It occurs as a smooth, doughy, indolent tumor, incompressible, not varying in size or shape, without heat, thrill, or pulsation of any kind, possibly having a few veins ramifying over its surface, but no distinct vascular appearance. It is usually congenital, or has been noticed in early childhood; and it continues without any very material change in shape, size, or appearance, until the inconvenience or deformity occasioned by it requires its removal. This is best effected by the knife. After removal, the tumor will be found to be composed of a cellulo-adipose basis, having a large number of veins ramifying through it, so as to constitute a distinct vascular element, communicating with small cysts containing a bloody fluid. The tumor has occasionally a tendency to recur after removal. In one case I have operated three times for the removal of a large growth of this description, situated on the buttock, and extending forward towards the perinæum. The first operation was performed in 1851; the second in 1856; and the patient, then eighteen years of age, again presented himself in 1863 with a recurrence of the growth in an ulcerated state, in the cicatrix of the former operations. The situation in which I have seen such tumors occur, where they gave rise to most inconvenience, and where their removal has required the greatest care, has been the anterior part of the thigh, just below Poupart's ligament, close upon and almost in connection with the femoral vessels. In a case of this description, which was sent to me by Edwards of Antigua, the patient, a gentleman of that island, had suffered for some years from a chronic solid œdema of one of his legs, apparently dependent upon the pressure exercised upon the saphena and femoral veins by an elongated indolent tumor just below Poupart's ligament, and over the course of these vessels. This tumor had existed from childhood, and presented the signs that have just been given as characteristic of the disease under consideration. It was removed by an incision parallel to Poupart's ligament, some careful dissection being required to separate it from the femoral sheath, more particularly towards the inner side, where a prolongation of the tumor dipped down by the side of the femoral vein, compressing that vessel, and so disposing to the occurrence of the œdema of the limb. After removal, the

tumor was found to consist of a mass of condensed cellulo-adipose tissue, with much vascular structure intermixed, and some small cysts. The œdema gradually subsided; and when the patient left England about three months after the operation, the limb had nearly regained its normal size, being but little larger than the sound one.

HÆMORRHAGIC DIATHESIS.

In connection with diseases of the arteries, it may be stated that in some constitutions it is found, though fortunately very rarely, that there is a great tendency to very troublesome, indeed almost uncontrollable bleeding, from trivial wounds; life being put in jeopardy, or even lost by the hæmorrhage resulting from the extraction of a tooth, the opening of an abscess, lancing the gums, or some equally slight unimportant surgical procedure. The blood does not flow in a jet, but continues to trickle in an oozing stream, apparently from the capillaries rather than from the arteries of the part. In these cases also there is a great tendency to inordinate ecchymosis from very slight contusion, the areolar tissue becoming rapidly filled with fluid uncoagulable blood. It is important to observe that by the "Hæmorrhagic Diathesis" is expressed a constitutional condition, that is unconnected with, and independent of, any physiological irritability or pathological change in the larger arterial trunks.

Causes.—The *Hæmorrhagic Diathesis* appears to be connected with or dependent upon one of three distinct conditions.

1. It may be congenital, and not unfrequently is hereditary, especially in the male line. In some families the males only have been affected, and the diathesis has been transmitted in the second or third generation through females; who, themselves being unaffected by it, have had male children who were the subjects of the disease. A very remarkable genealogical account of such a family has been drawn up by C. Heath. This diathesis occurs in persons otherwise robust and strong, without any apparent derangement of health, or morbid condition, innate or acquired, to account for it. In such cases the family peculiarity is usually recognised, and well known to those liable to it.

In these families of bleeders, it is scarcely necessary to say that it is imperative to be careful to make no surgical wounds, even of the most trivial character, if they can possibly be avoided. Above all, the extraction of teeth must be avoided. It is after this slight operation that the most uncontrollable and fatal hæmorrhages have occurred. The hæmorrhages, though usually traumatic, may be spontaneous; they then usually proceed from the nose, bowel, kidney, or subcutaneous connective tissue. In women they assume the character of profuse and uncontrollable menorrhagia. The hæmorrhages are accompanied by the symptoms described at page 279, as characterising excessive loss of blood; and after their cessation the patient usually remains anæmic for many weeks or months. The quantity of blood lost is often enormous, amounting in some cases to several pounds in the twenty-four hours.

Formerly it was supposed that females were exempt from hæmophilia. But Dr. Wickham Legg, to whom we are indebted for an excellent monograph on this condition, states that this assumption can no longer be maintained, although women are far less disposed to the disease than men; that they present few instances of the more typical forms of the disease; and that it is less fatal in them than in men. Most of the fatal cases in women have occurred by hæmorrhage from the genital organs; and Legg quotes a case from Wachsmuth, "where the rupture of the

hymen on the marriage-night caused the death of the bride from hæmorrhage."

A frequent symptom accompanying this diathesis is a painful and sudden swelling of one or more joints either occurring spontaneously, or as the result of some slight injury. The swelling is the result of an effusion into the synovial membrane, of blood and synovia. It may last only a few days or may endure for months. The joint is often permanently weakened, and relapses are frequent during the cure.

2. Hæmophilia may occur in individuals from some fault in the solid constituents of the body, in consequence of which the smaller vessels rupture too easily, and when divided do not contract with sufficient readiness. There appears to be every degree in the tendency to bleed abnormally, from persons who, being "out of condition," and having the tissues soft and flaccid, bleed freely and bruise extensively from trivial wounds and slight blows, to those who are affected with true hereditary hæmophilia. The bleeding in these cases is maintained by the laxity of fibre preventing the proper contraction of the divided or torn vessels; and the tendency to hæmorrhage will vary at different times in the same person according as the state of his health improves or deteriorates.

3. An abnormal tendency to hæmorrhage may depend upon a morbid state of the blood itself, in consequence of which its coagulability is diminished or even lost. This state is often met with in diseases such as scurvy, chronic jaundice, and albuminuria, that produce a diffluent state of the blood. The condition of the blood in true hæmophilia has attracted the attention of many Surgeons and Pathologists. It has been stated to be watery, deficient in red corpuscles and in fibrine, and uncoagulable. But more accurate chemical examination than has yet been made is required to determine the exact proportion of its constituents; and as to its coagulability there appears to be no difference between hæmophilia and healthy blood in the earlier stages of a hæmorrhage. At the more advanced periods, when the patient has become anæmic, the coagulum becomes weaker, and at last ceases to form altogether, the blood being watery and only tinged with coloring matter.

It would appear then that the only facts of importance that we at present possess to throw light on the cause of hæmophilia, are, that it is hereditary; that it is far more frequent in males than in females; and that in may occur at all ages and in all countries.

The relative parts played by the solid constituents of the body, the blood-vessels, and the blood, are absolutely unknown, as is its exact pathology. From the influence exerted by local applications, there is, however, reason to believe, as will be immediately stated, that the solids rather than the blood are at fault, and that one element in the disease is certainly a want of proper contractility of the arteries.

Treatment.—In the constitutional treatment of a hæmorrhagic tendency dependent on those conditions that alter the constitution of the blood, such as scurvy, chronic jaundice, &c., much may be done by appropriate medical means. But in the true hereditary hæmophilia, no remedies appear to exercise the slightest influence over the diathesis. At the same time, it would be wise that the subject of this unfortunate condition should attend to those ordinary rules of health, the neglect of which, by "lowering his condition," might favor the tendency to bleed. Legg especially recommends the use of cold baths of plain, sea, or chalybeate waters, residence in a dry air, and the use of warm clothing. The preparations of iron are usually given in a routine way, but it is doubtful if they have ever been of service in preventing the hæmorrhages, cer-

tainly never in arresting them, though they may be of use in removing the anæmic state left after a copious bleeding.

The *Local Treatment* is that on which most dependence will necessarily be placed. It consists in the use of three means—viz., Pressure, Styptics, and Cold.

Pressure is only to be relied on in one form of hæmophilic bleeding —viz., the continuous hæmorrhage from the socket of a tooth after extraction. In these cases the cavity should be cleared out and carefully plugged from the bottom by means of lint or agaric, the whole retained by means of a piece of cork and a gutta-percha cap to fit over the neighboring teeth, and compressed by a bandage applied under the chin against those in the sound jaw. When the hæmorrhage occurs from the soft parts, pressure must be used with great caution lest sloughing occur; the integuments being extremely liable to give way extensively under very moderate pressure, large subcutaneous extravasation developing at the same time, thus increasing materially the danger of the case and the local mischief.

The compression of the main artery of the limb is useless and liable to the objection of the development of ecchymoses and subcutaneous hæmorrhages.

Styptics of all kinds have been used as a matter of course, and the perchloride of iron has enjoyed especial favor. I have used and seen it used frequently in a family of bleeders, members of which have for many years past been in the habit of coming to the University College Hospital for the arrest of hæmorrhages. I can safely say that I have never seen any permanent benefit from the application, or that of any other styptic, in these cases.

Indeed, great evil has often resulted from the inflammation excited by the application of styptics of any kind. The parts become swollen, fall into slough, and as they separate the area of the raw and oozing surface extends, and the same process has to be gone through over again.

The *actual Cautery* presents the same inconveniences as ordinary styptics. It may arrest temporarily the bleeding, but inflammation is set up in the parts beyond the limit of the eschar, and this on separating leaves an extended ulcerating surface which bleeds again, and perhaps more freely than before.

The continued application of **Cold** appears to arrest hæmophilic bleeding more effectually than any other means, and this circumstance would lead to the belief that the hæmorrhage is due to want of contractility in the smaller arteries rather than to want of coagulability in the blood. The cold may be applied by means of irrigation of iced water, as has been done successfully by Marshall, or by the application of ice either directly to the part or laid upon a sponge covering it, as has been done by Beck in some of the hæmophilic cases occurring at University College Hospital. Simple water may be used, or a weak antiseptic solution of boracic acid. If the bleeding wound be in the extremities, the limb should be kept absolutely at rest on a splint.

The Surgeon has already been cautioned as to the inexpediency of performing any operation, except under circumstances of the most urgent necessity, on any member of a family of bleeders, or on an individual known to be the subject of hæmophilia. Should an operative procedure become necessary, it should, if possible, be undertaken with the galvanic knife, if it be desired to make a simple incision; by the galvanic écraseur, if it be expedient to remove a part or to perform a small amputation. In the event of the galvanic écraseur not being at hand, the *elastic ligature* would be the best substitute.

INDEX TO VOLUME I.

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